NOVEMBER 1965 35 CENTS

Popular Science

MONTHLY

Why Can't We Make Cars Safer?
By SEN. ROBERT F. KENNEDY

My Adventures on Wheels
By ERLE STANLEY GARDNER

COMPLETE PLANS: A Lock-Up Workbench That Protects Your Tools

FIRST '66 ROAD TESTS
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10 Sure Ways to Improve Your TV Picture

Now It's Man Amplifiers: MACHINES THAT LET YOU CARRY A TON

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SPECIAL FEATURES NOVEMBER 1965

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Why Can't We Make Cars Safer? PAGE 63

SEN. ROBERT F. KENNEDY—deeply concerned about the mounting toll on our highways—offers a plan to reduce the hazards of cars, roads, and drivers.

Man Amplifiers: Machines That Let You Carry a Ton PAGE 70

A remarkable project now under way at Cornell Aeronautical Laboratory is developing a "superman suit" that will multiply a man's strength many times.

My Love Affair with Sand and Wheels PAGE 112

ERLE STANLEY GARDNER, famous creater of Perry Mason, reveals his life-long passion for exploring the western deserts in many weird vehicles.

10 Sure Ways to Improve Your TV Picture PAGE 122

Here's how you can cure the poor-picture blues without buying a new set—starting with precise directions for adjusting the "up-front" controls.

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The latest in a series of money-saving articles on home wiring tells you how to wire your workshop for maximum efficiency, safety, and convenience.

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Plus a fact-filled 12-page bonus booklet to keep beside your set—"Color TV: How to Live with It—and Love It."

In the same issue: Report from the Driver's Seat—Jan Norbye tests some of the most exciting '66 cars . . . How a Booster Heart May Save Your Life . . . Henry Ford II Discusses Car Safety . . . Sneak Preview: Chevy's Answer to the Mustang . . . Crazy Gadgets in "The Man from U.N.C.L.E." . . . How to Get Your Money's Worth When You Rent a Car . . . The Inside Story on Outboard Spark Plugs . . . How Much of Your Job Belongs to You? . . . Complete Plans for an Earthquake Detector . . . A Toolbox for Every Home . . . Where's That Drain Stoppage? . . . How Two Can Live Happily in the Same Room . . . New Switches for Home Wiring.

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Carburetor gum can choke the life out of your engine

Remove it easily with GUMOUT

THE gasoline constantly being evaporated in your carburetor leaves a residue of varnish and gum. As this builds up, your carburetor has trouble "breathing." The symptoms are hard starting, stalling, rough idling, power loss, poor gas mileage.

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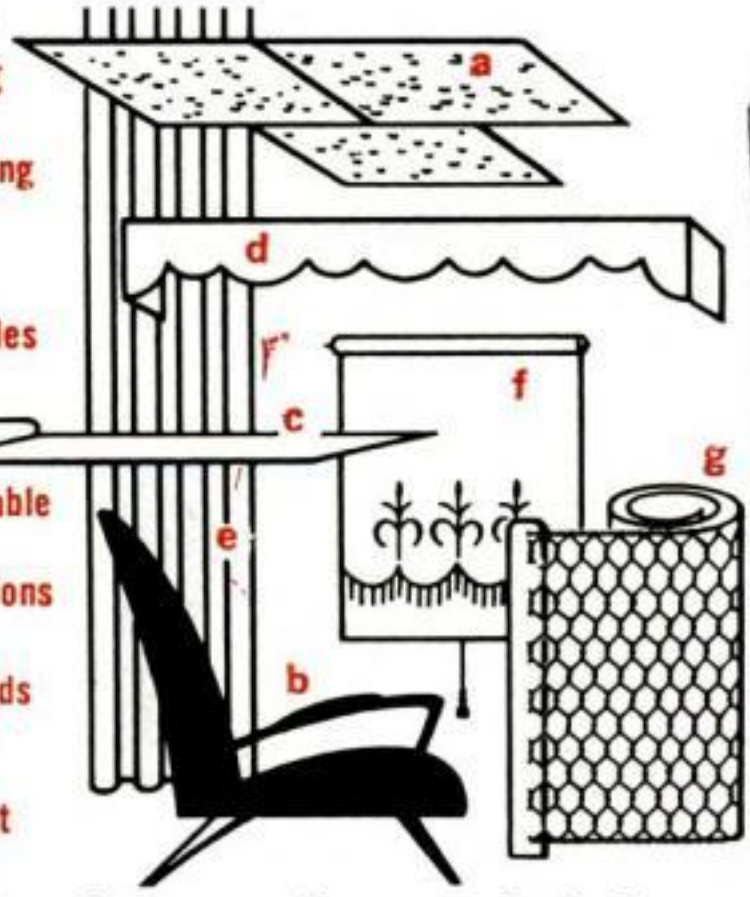

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PS readers talk back

Want to get something off your chest? Write "Readers Talk Back," Popular Science, 355 Lexington Ave., New York, N.Y. 10017.

"Home" of the Jungle Experts

"I Survived a Jungle Survival Test, Could You?" [Aug.], asks Robert Gannon. I did—at the Jungle Warfare Training Center, Fort Sherman, Panama Canal Zone. You don't just go for a walk, you hike for two months. If you don't pass, you go for another two months. Gannon moans of bugs and heat. That's nothing compared to what we had on night navigation in the jungle. You can walk into a palm tree covered with needles that a medic has to dig out, sleep in the bush, and get bitten by spiders, bats, and snakes. If you want to hear some real survival stories, talk to a graduate of this jungle school.

C. V. Potter, Palmdale, Calif.

The Lure of Treasure

I read with interest "How Jon Lindbergh Works on the Ocean Floor" [Sept.], especially the material dealing with new diving methods for deep-sea salvaging. One project that should lend itself beautifully to the equipment and talents of Ocean Systems, Inc., is salvage of the Andrea Doria. Although skin divers have reached the 390-foot-deep ocean liner, she is too deep for regular salvage divers to work. Literally millions of dollars are involved in successful raising of the ship.

Gilbert Jandera, San Diego.

A spokesman for Ocean Systems, Inc., comments: "Of course our diving systems could be used to salvage the Andrea Doria, just as they can be used for other underwater work. Whether this is a desirable project is another matter."

Many salvagers feel the cost of raising the ship would be greater than the scrap value of the sunken hulk; accounts of valuable cargo aboard are generally discounted.

Old-Hat Department

So Steve Owens ["I'd Like to See Them Make," July] wants a coping saw with a swivel knob to turn the blade 90 degrees to the handle (when necessary) without taking the saw apart. The Parker Mfg. Co., Worcester, Mass., makes one you can rotate 360 degrees and lock in any position without dismantling the saw. I bought one in a local hardware store—with four blades—for 98 cents.

J. O. Peterson, Winneconne, Wis.

Good News on Mike

I just bought the Dynaco stereo mike ["What's New in Electronics," Oct.]. Everything you say about it is true—except the price. I paid $150 for mine, not $200.

J. L. Osborn, NYC.

Right. The Dynaco people tell us the mike now sells for that price.

Here Endeth the Second Lesson

As a buyer of cars over the years, the things I've learned would fill a book. After the hushed—even carpeted—quiet of the display floor where the buyer is king, learning the first lesson is hardest: The sales room and the service department do not know each other.

The service department is a world of its own. You wait in a drafty garage, trying to catch the eye of the Manager. Although you come in at 8 a.m., he disappears periodically. Suddenly the whole place empties. It is now 9:30 and you're living through the coffee

break. The men slowly dribble back and it's your turn. This is where you learn the theme song: Leave it here and pick it up tonight!

Everything is written down. At night you pick up your car—and the bill. How beautifully all your complaints have been canceled out with almost uniform checkmarks. It takes only a little while to find out that nothing is changed. You go back with your complaints, and learn lesson number two: All of sudden, it's all your fault!

W. Stingelin, Astoria, N.Y.

They're All Bred to Go

As an ardent four-wheeler, I missed the off-the-road driving suggested by the title: "Test-Driving the Ruggeds" [Aug.] and, as the

[*Continued on page 8*]

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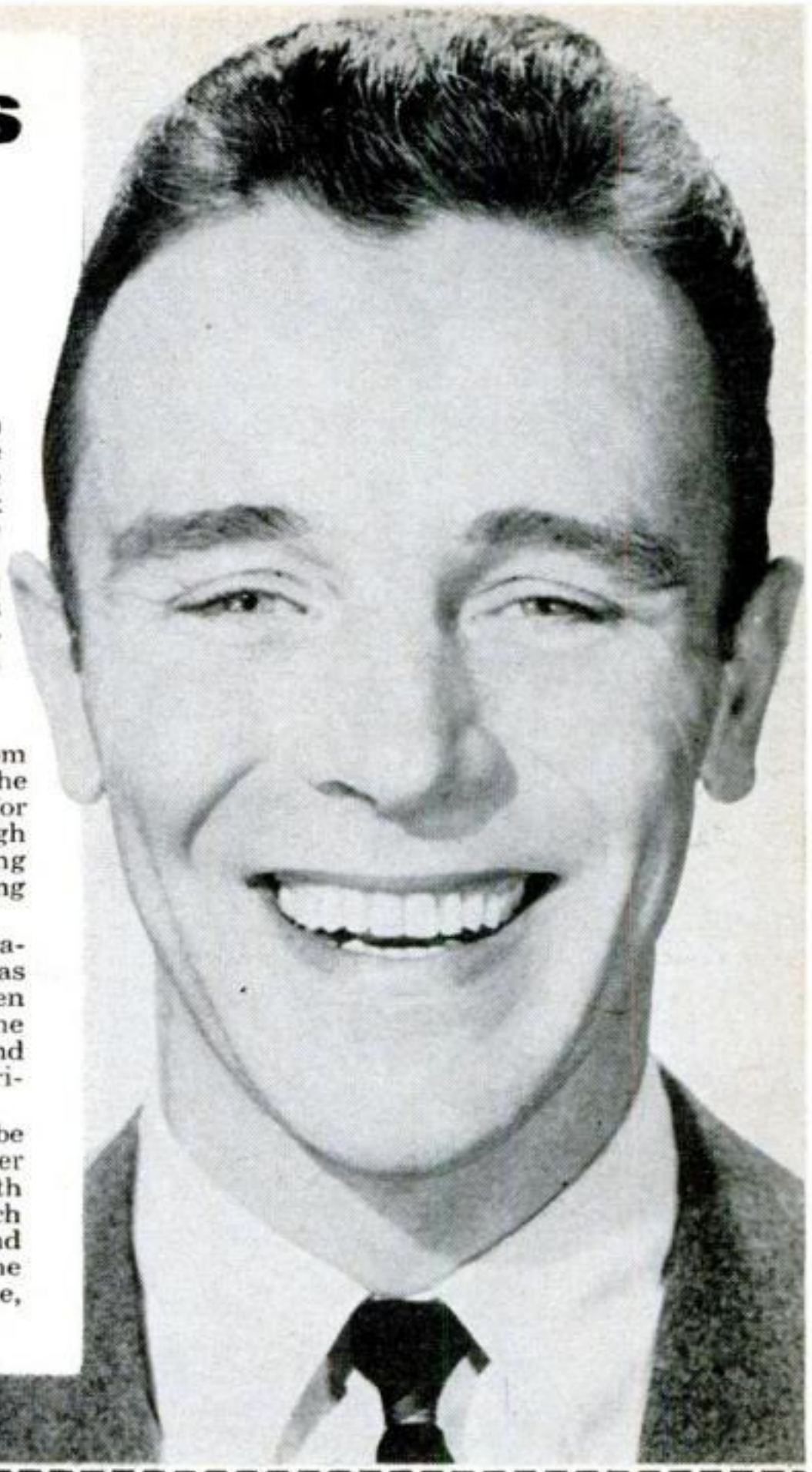
"Look who's smiling now!"



"The department head's job had just been left vacant. When the boys in the office learned I was gunning for it, they gave me their widest grins. One thing they didn't know: I had made up my mind sometime back to take LaSalle training that would prepare me for a better job. My study paid off so fast it surprised even me—I was picked for that shiny promotion over everyone's head. Who wouldn't be smiling with a neat new $1,500 increase!"

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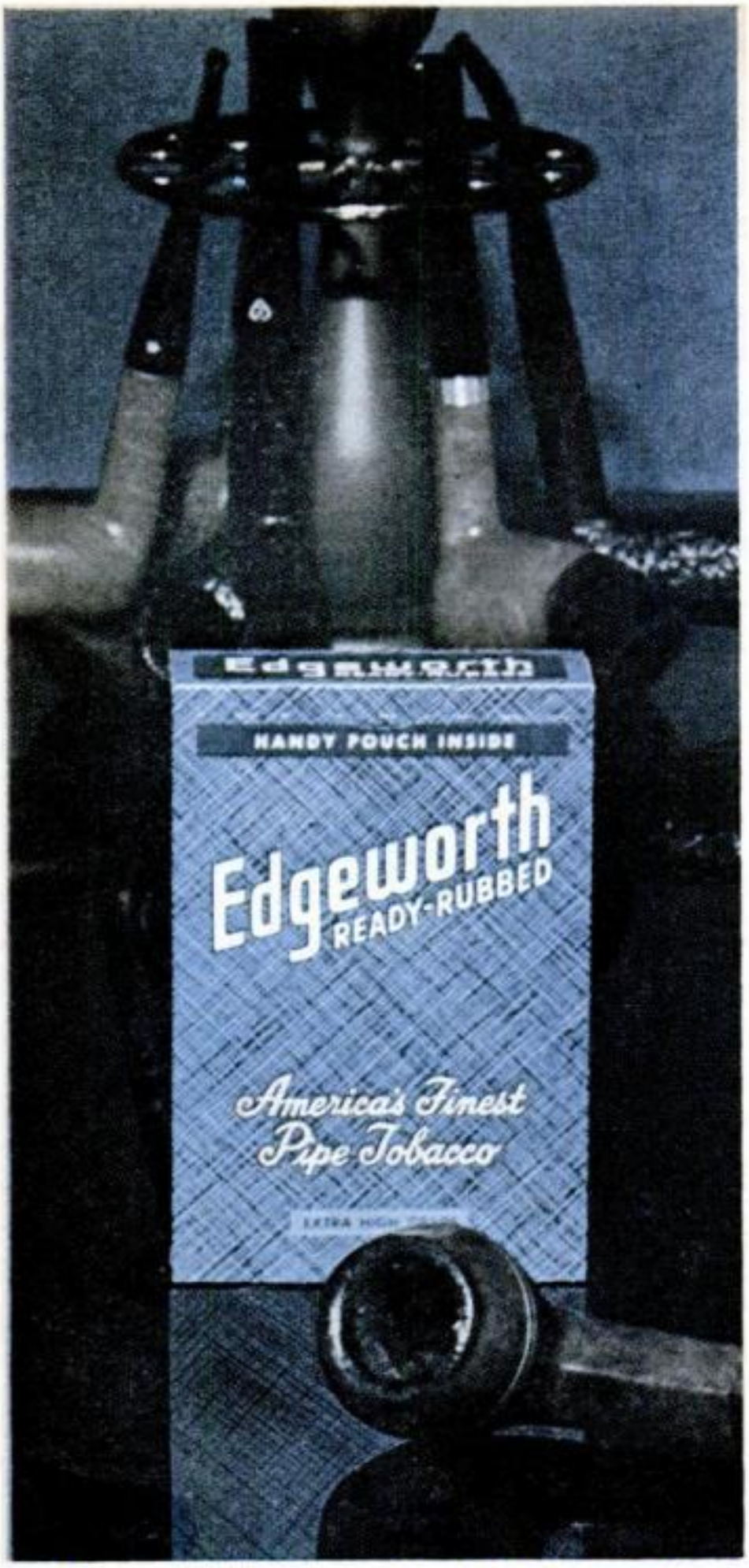

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[Continued from page 6]

owner of a Toyota Land Cruiser, I was disappointed by its absence in the comparisons. May I test THE rugged with you:

The price ('65 early model) was $2,850, including two options: "Huskey" hubs and a heater (Ford truck model). The standard equipment was not only sufficient, but more complete than that of other makes.

The Toyota's body is narrowest (65.6 in.) and its turning diameter shortest—important to backwoods drivers. Its 18.5-gallon gas tank (largest) coupled with 16 m.p.g. (I get it consistently) eliminate carrying jerry cans, popular with other four-wheelers.

The real measure of civility among four-wheel cars is possessed only by Toyota: no gear controls jutting up from the floor. Just try riding three comfortably in the front seat of any rival!

Land Rover's overall gearing ratio (low gear × low range × rear-end ratios) is the highest, but gears are multipliers of *available* torque only. The maximum axle torque and the engine r.p.m. at which it is available (see chart) are the real measure of off-road power.

Vehicle	Max. Axle Torque (Ft./lb.)	Engine R.P.M. @ Max. Torque	Wt./Hp. Ratio
Bronco	5,034	2,400	29.5
Jeep	4,013	2,000	30.3
Nissan	5,513	2,000	25.1
Rover	5,034	2,500	38.7
Scout	4,131	2,400	35.2
Scout with turbo-charger	5,080	3,200	27.5
Toyota	5,664	2,000	24.1

Just as in horse racing, it's often wiser not to bet on the favorite, but on the entry that's capable of showing the most for the money.

D. E. Dietrich, Boulder, Colo.

We Get a Bouquet

I want to thank you for a feature that I feel is important—the layout of your do-it-yourself articles, complete in themselves without continued sections at back of the magazine. This is a boon for my cut-out-and-file system. Don't worry that I might miss any ads. The first time through, my PS is covered page by page, for I find more new products there for my use than in any other form of advertising. Thanks for an excellent magazine.

Thomas C. Wendell, Milwaukee.

You say ["Now Everybody's Riding Cycles," July] that a four-stroke engine is more efficient, especially at lower speeds, than a two-stroke one. A Suzuki publication says: "Most engineers will agree that the two-stroke

[Continued on page 44]

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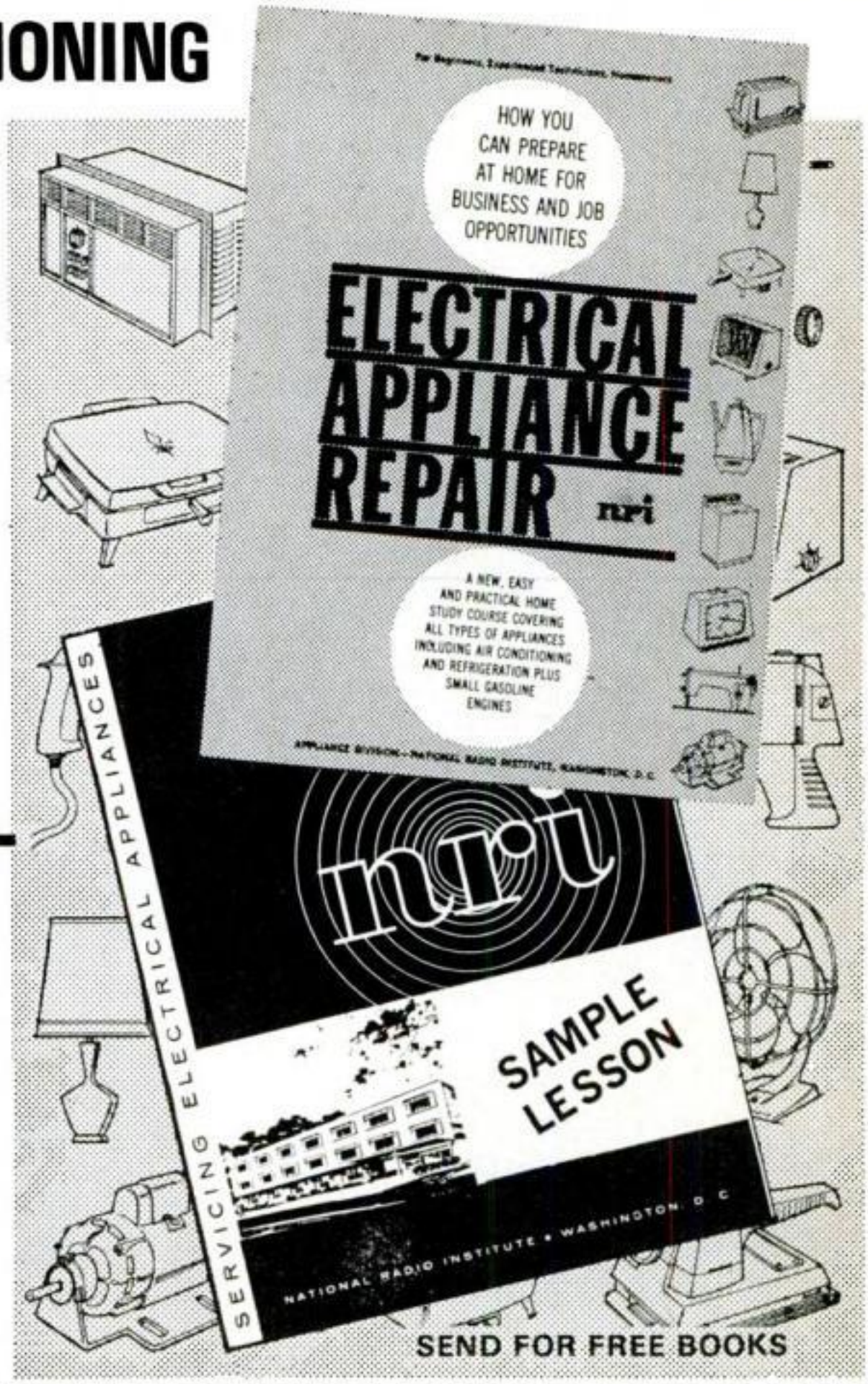
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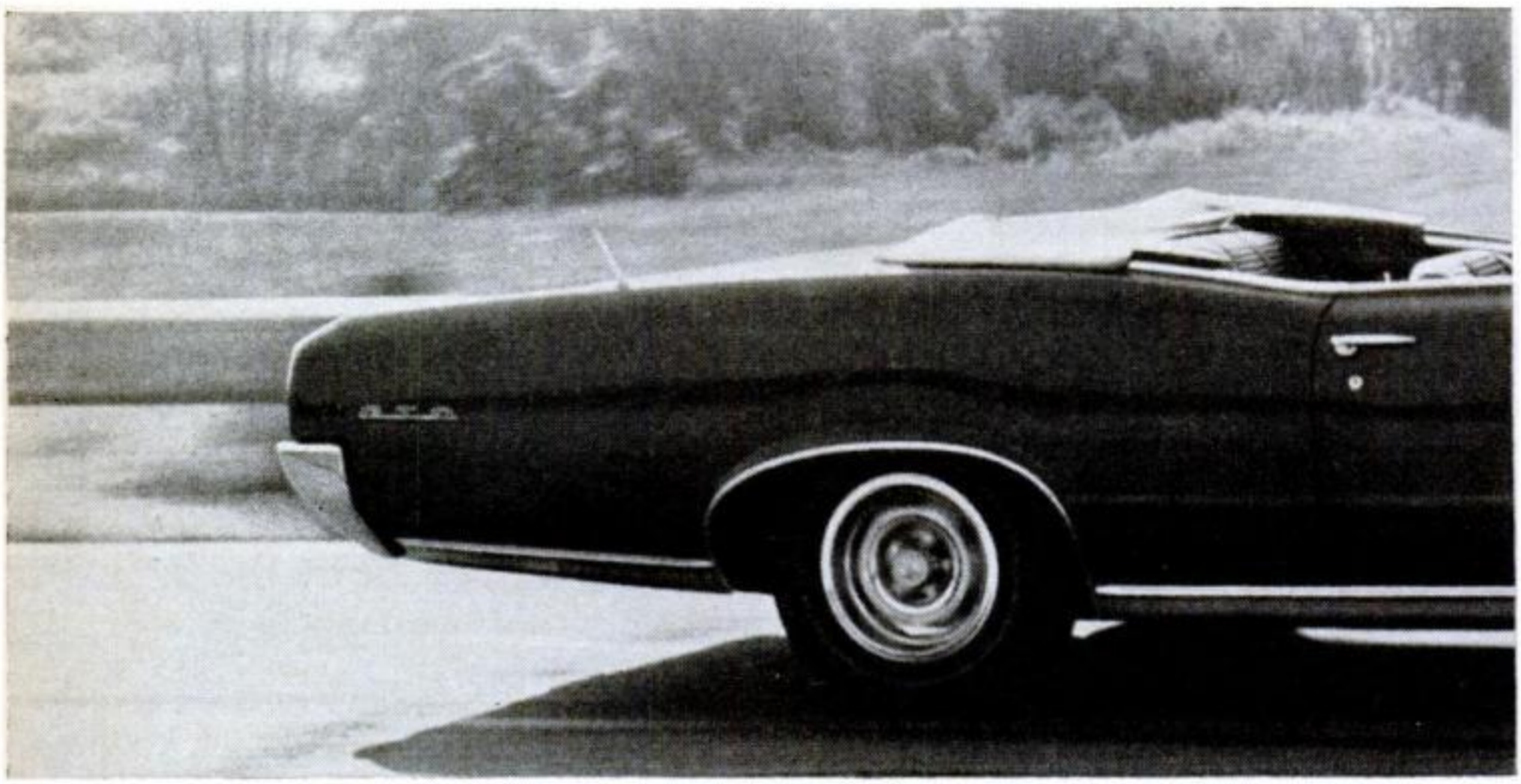

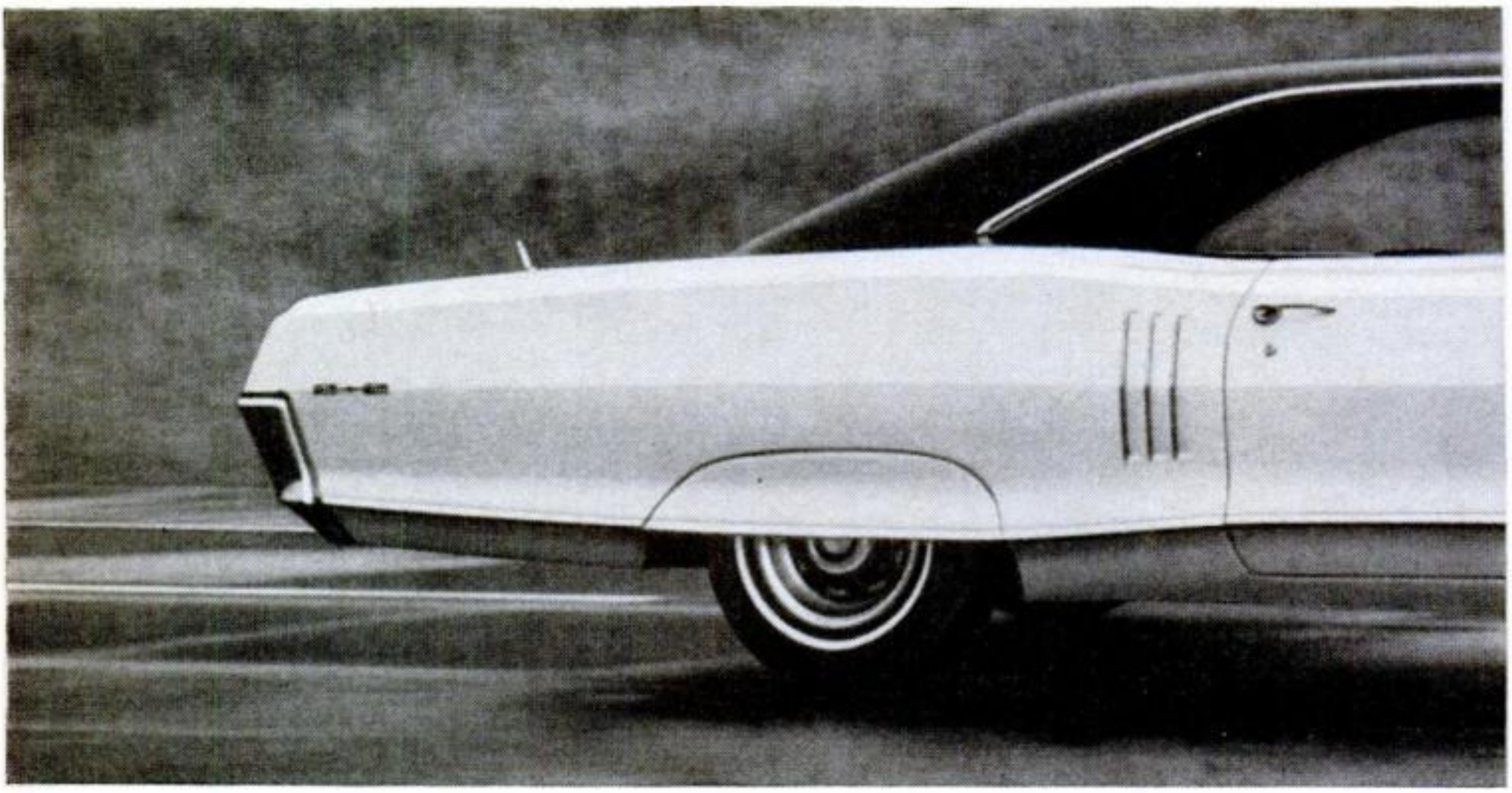

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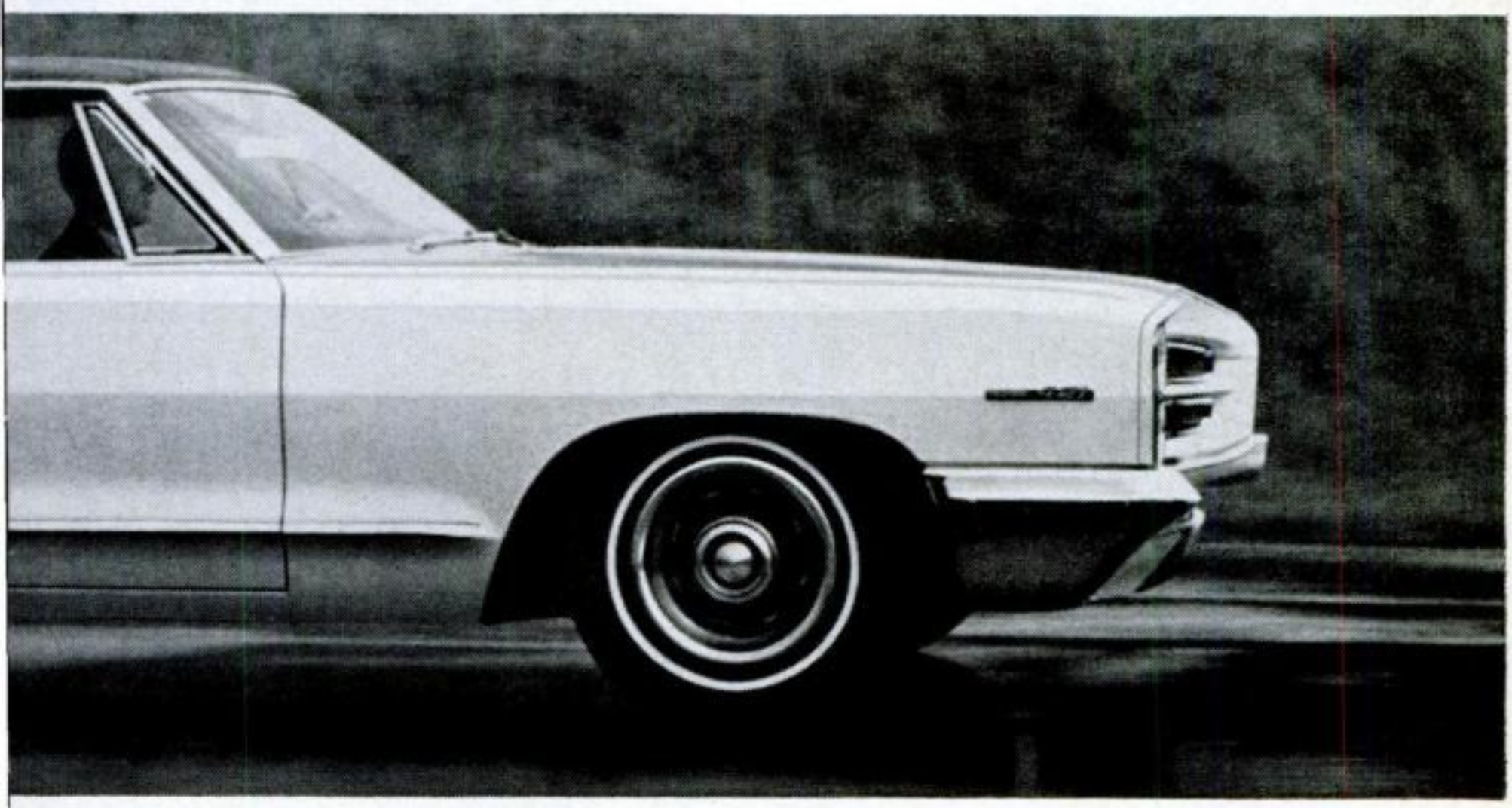
That heroic time-machine you see on top is the new *Gran Turismo Omologato*, otherwise known as the redoubtable Pontiac GTO. Under its hood is a 335-hp engine with quad carburetion that delivers torque as if the supply were limitless—431 lb.-ft. at 3200 rpm. There's a 360-hp version with 3 2-barrels. Standard box is a 3-speed all-synchro column shift. Heavy-duty 3-speed or four-speed are available, both with Hurst floor shifter. New buckets are practically wraparound. Suspension? Heavy-duty, of course. Options? You name it, we've got it. Probably chromed.

Below the GTO is its illustrious counterpart, the Pontiac 2+2. Its standard 421 cubic inch engine delivers 338 hp and 459 lb.-ft. of torque out of a four barrel. And you can specify up to 376 hp with a tri-carb. Like the GTO, air cleaner and rocker covers are chromed, body pinstriped. Inside there are enveloping new buckets, carpeting, an all-synchro 3-speed floor shifter.

And remember we practically invented performance options. For the last word, see your Pontiac dealer and get the GTO/2+2 catalog.

Pontiac Motor Division • General Motors Corporation



The tiger scores again! Wide-Track Pontiac/'66

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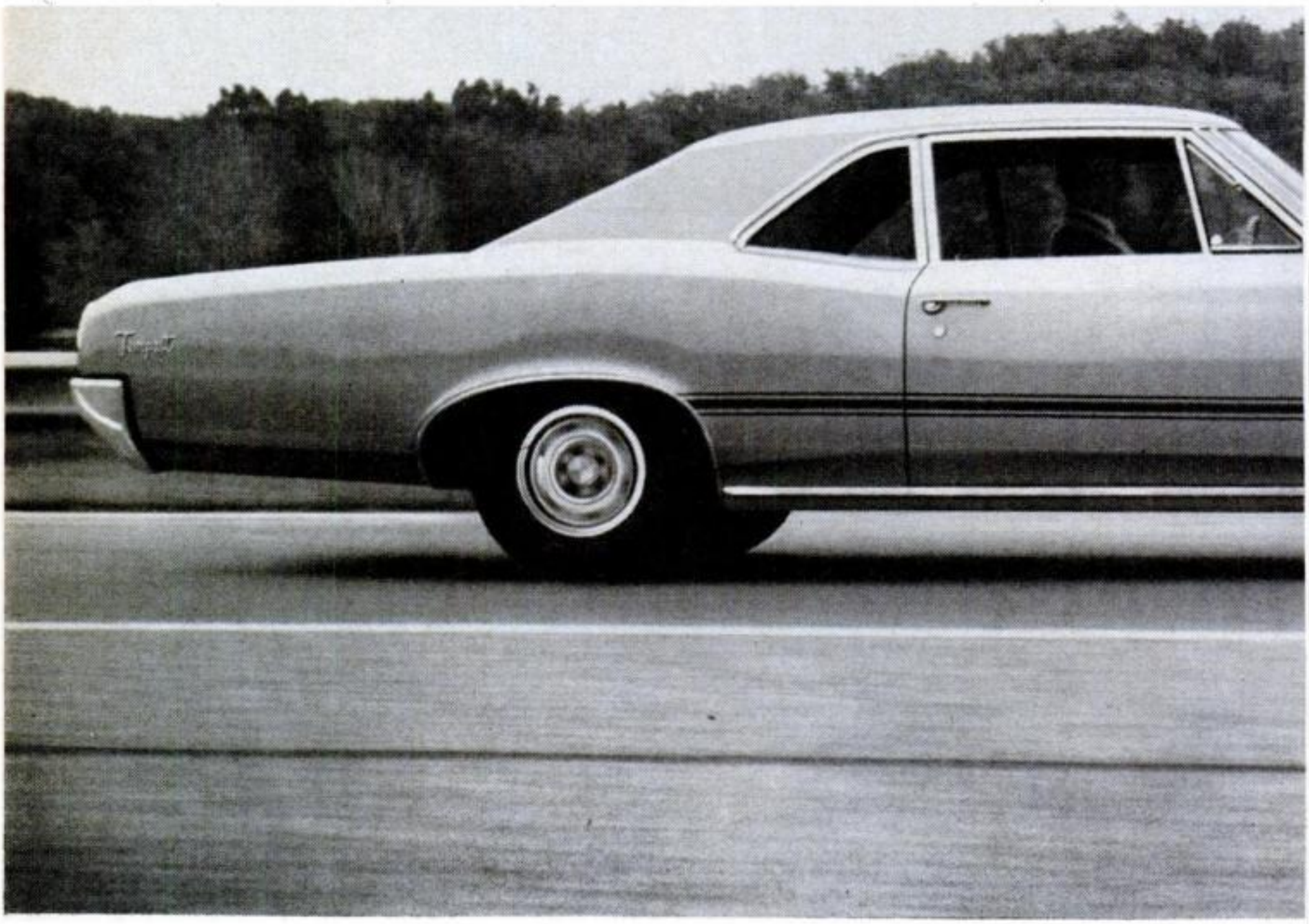
Since when is a six a surprise?



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In its 165-hp form (standard on all Tempests, Tempest Customs, and LeMans), our new six isn't going to surprise many people. Even if it is an overhead cam job. But don't knock it. Only a dozen years ago, engineers were busting their bearings to squeeze that out of a production *premium gas* V-8. Our six does it on regular.

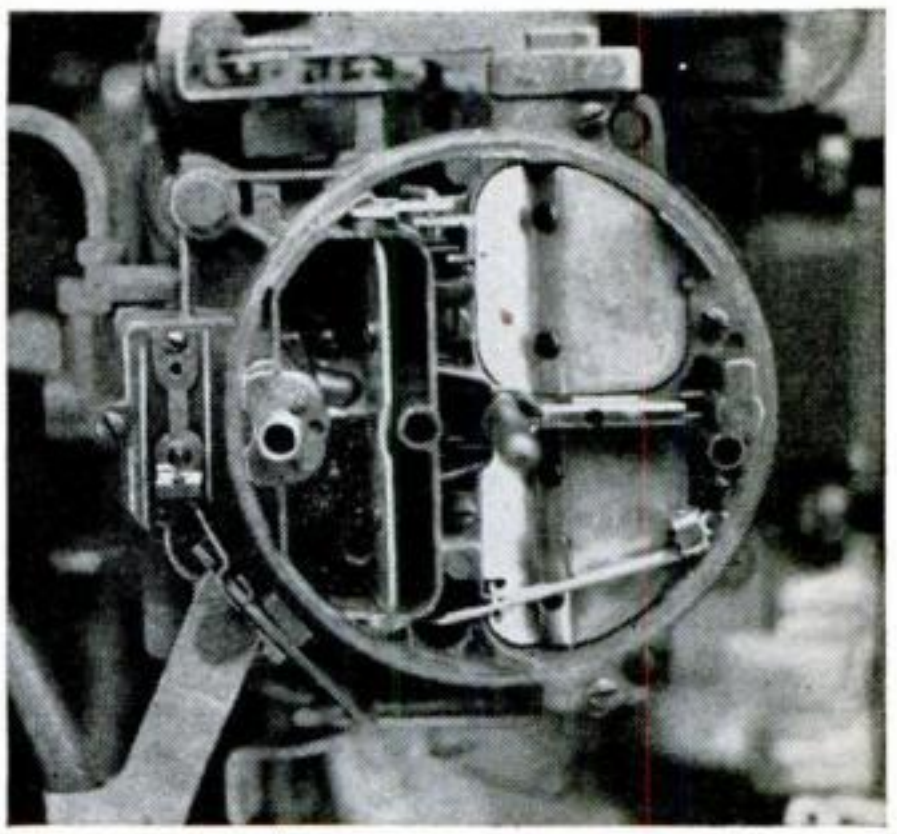
The engine we're talking about is the 207-hp high compression version. It comes with a four-barrel Quadrajet carburetor, a split-manifold exhaust system that sounds like thunder in the Alps, and a chromed air cleaner in a package that includes heavy-duty shocks, springs, and stabilizer bar, an all-synchro 3-speed with Hurst floor shifter, distinctive emblems and sport striping. Or you can order our new, all-synchro close-ratio 4-speed.

The OHC-6 weighs in at a couple of hundred pounds less than V-8s of comparable horsepower, so you can see how the power/weight ratio escalates.

You can order the 207-hp package in any LeMans, Tempest Custom, or Tempest (except wagons). Read more about this new kid on the block in the GTO/2+2 catalog.

Pontiac Motor Division • General Motors Corporation

Starting right now!



The tiger scores again! Wide-Track Pontiac/'66

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'Say, Smokey–'

A clinic on cars by America's most famous mechanic

EACH month in POPULAR SCIENCE, Smokey Yunick will answer questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Ask Smokey. You'll find the address at the end of the column. Please *print* your name and address.

►***"In damp weather my '65 Chrysler Newport with a 383-inch engine and two-barrel carb runs rough until it dries out. My mechanic says, 'Spray and pray—dry weather will soon be here.' What else can I do?"—Bob Westley, Niagara Falls, N.Y.***

Install waterproof plug wires, some rubber spark-plug boots, and a clear-plastic distributor cap. Also move the coil to a drier spot, and your weather problems will be at an end.

►***"Every so often the standard shift on my '64 Buick Special gets so mixed up that I can't use it—until I raise the hood and push the short lever back down where it belongs. The garage I patronize hasn't helped me any."—W. H. Van Petten, Fenton, Mich.***

All three-speed manual shifts with the lever on the steering column operate on the same principle. When they are not adjusted properly, you automatically become a member of the Greasy Hand Club. First, check that no parts are worn beyond adjustment, then get the shift into neutral. Adjust the rods so that the notches in the little shifter box are aligned.

►***"Will it hurt an engine, or anything else under the hood, to steam-clean each three months or so? I get contrary opinions on this."—Tom Turrisi, Falls Church, Va.***

Steam, and the detergents used in it to remove dirt, will also remove paint. More important, it will remove the weatherproofing and insulation on the electrical system. I don't think frequent steam-cleaning pays off. I'd skip it.

►***"My '65 Ford V-8 352-inch pickup with automatic is hard to start when left standing 15 minutes or more. It starts harder hot than cold. The dealer says the plugs, points, and timing are okay. Also, I am having a hard time keeping the valve-cover bolts tight. Every few days they get loose, spilling oil over the manifolds. What can I do?"—Fred Flanders, Dublin, Ga.***

The hard-starting problem is caused by heat expanding the gas, as I have so often stated in this column. Baffles to shield the gas-feed line up to and including the carburetor will help.

You can go further and make a second attack on this problem by keeping gas in the carburetor bowl when the engine isn't running. (If you solve this one cheaply, they can use you in Detroit.) Start by installing a neoprene needle-and-seat combination, and replacing the metal gas line with the new neoprene-and-fabric tubing. A fuel-pressure regulator may help, too. Get Nylock type bolts for the valve covers, or use Loc Tite on the present bolt threads.

►***"My 1961 Plymouth 381-inch V-8 has 77,000 miles on it. Lately, it has been smoking very badly when started up. Compression tests show all cylinders within the 125-135-pound range. The carburetor recently was overhauled, and the engine has new plugs. However, I've had no gen-***

CONTINUED

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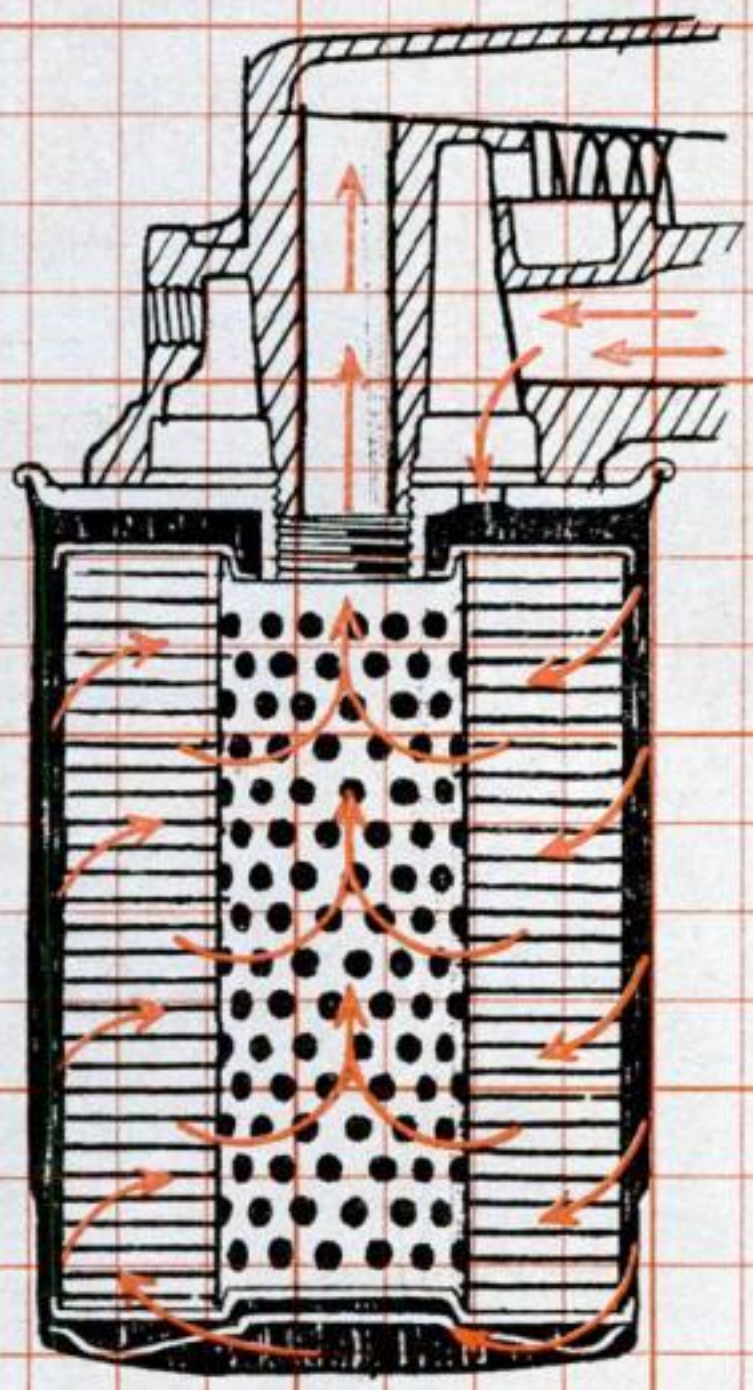
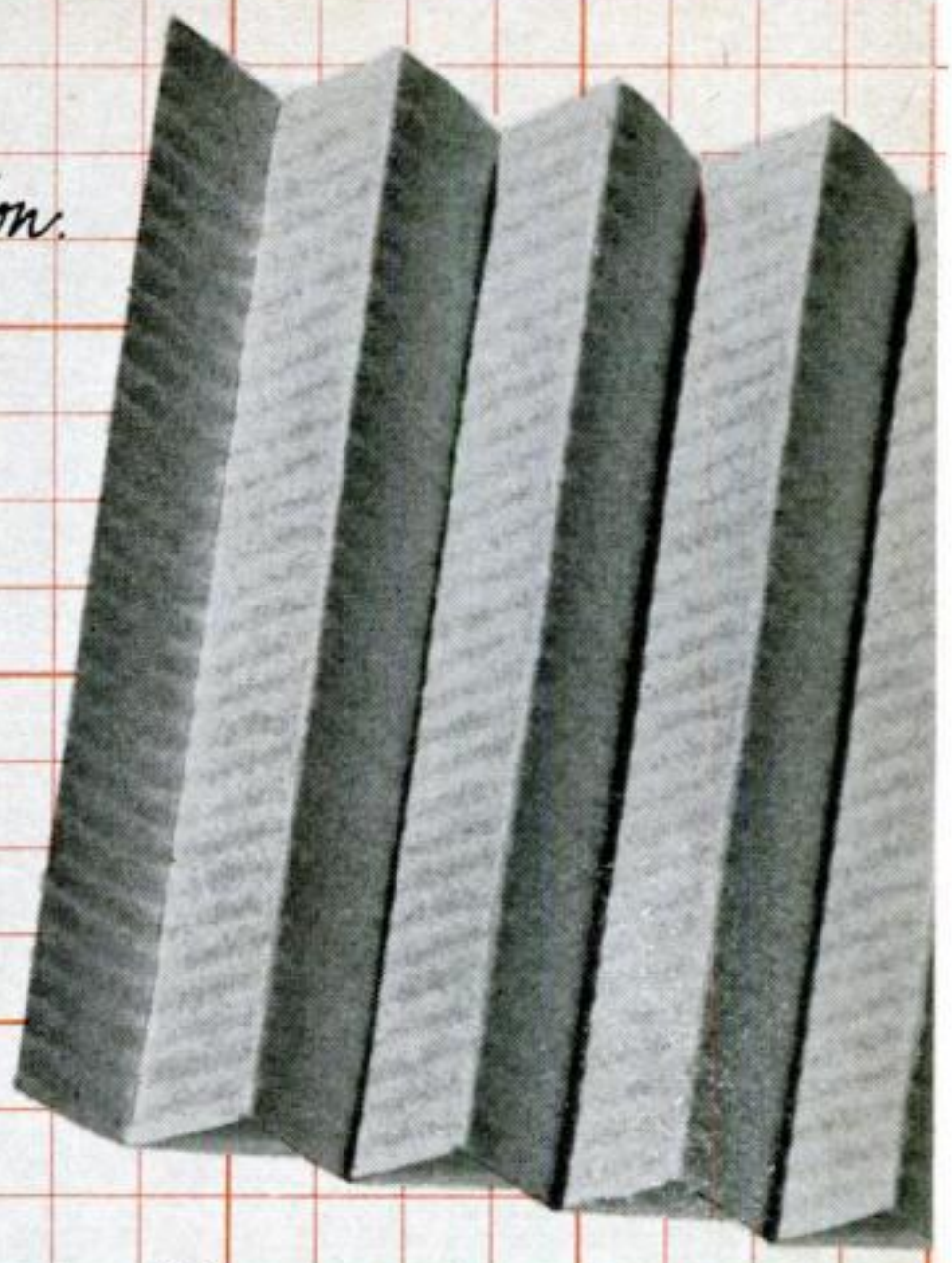
From an AC Engineer's notebook:

AC's full-flow design gives continuous filtration.





AC's specially treated filter material assures maximum flow of clean oil.

Here's how the AC Oil Filter protects your engine against wear

The AC Full-Flow Oil Filter combines fast (600 quarts an hour*) continuous filtration with greatest filtering efficiency. AC's specially processed filtering material assures resistance to acids, water and high operating temperatures. This process also adds strength and rigidity to the filtering material to help assure the same high degree of performance throughout its life. During the recommended service period, the AC Oil Filter effectively removes abrasive impurities that invariably result in engine wear. For more miles of top engine protection, always install a new AC Oil Filter when you change your oil.

*Average recirculation time

AC SPARK PLUG DIVISION OF GENERAL MOTORS

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Ronson introduces the

(Complete with large-

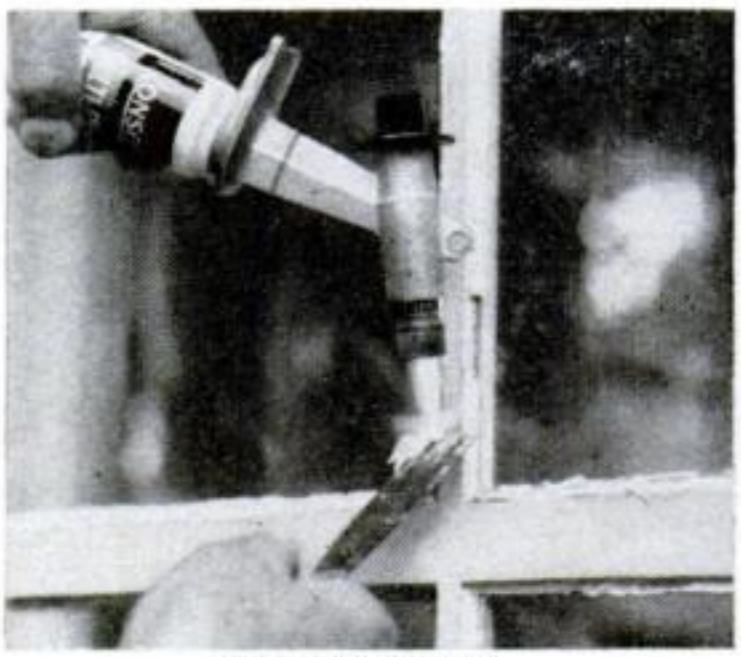
Burns for hours on butane gas. Adjusts from pinpoint to

STARTS LOG FIRES.

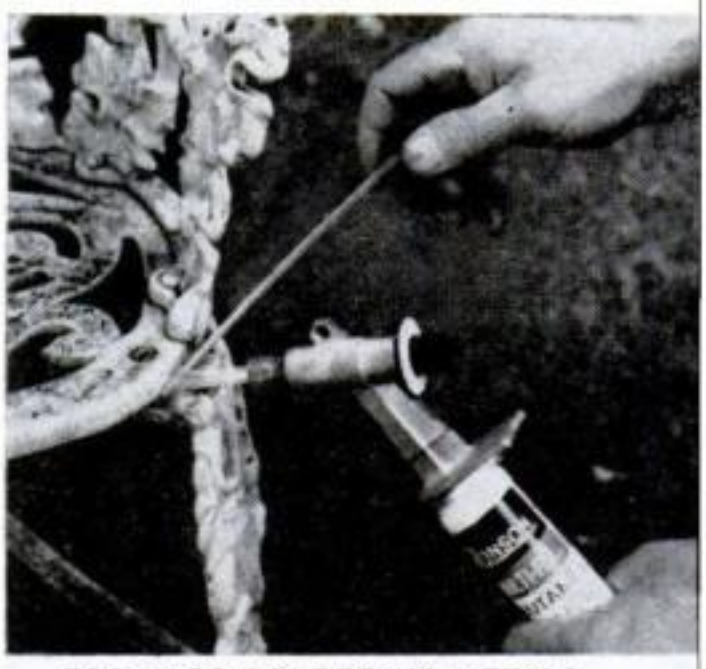
MELTS ICE.

STARTS CHARCOAL FIRES.

REMOVES PAINT.



SOFTENS PUTTY.



FOR HARD-SOLDERING METALS
SUCH AS THIS METAL CHAIR.

O.K. You own a hammer, a chisel, a screwdriver—a lot of good, hardworking tools.

So when something at your house needs fixing, you're ready, willing and able to go to work.

Or are you?

Ever try to thaw a frozen water pipe with that hammer?

Or unstick a cracked floor tile with that screwdriver?

Or chip ice off the front steps with that chisel?

Humiliating, isn't it?

(Not having the right tool at the right time can make you feel about as self-sufficient as an old-maid schoolteacher fixing her first flat tire.)

But now Ronson has a new torch that can do all those things. And more.

You don't have to be a handyman to put it to work. It starts charcoal and log fires quickly. It burns leaves and caterpillar nests. You can even use it to put a nice brown meringue on Baked Alaska!

It weighs less than 13 ounces. Much smaller than other leading torches, it takes very little storage space. It's as compact and easy to handle as a flashlight.

A blast from this torch can spot-kill a weed faster than you can yell "Crabgrass!"

A broken wire fence needs mending?

This torch can do a perfect soft-solder job in less than a minute.

It can hard-solder a ½" copper tube to a brass elbow in just a few minutes.

It can help remove old paint.

Soften old putty.

Fix a kid's toy.

Help refinish furniture.

Sweat copper tubing.

(Whew!)

Loosen rusted pipe fittings and connectors. (Just try to get in and around pipes and fittings with a larger torch.)

Free frozen nuts and bolts.

And even stand up like a laboratory burner.

(This comes in handy when you need both hands free.)

How did Ronson put this new torch together?

We used butane gas, and the

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size butane Multi-Fill.)

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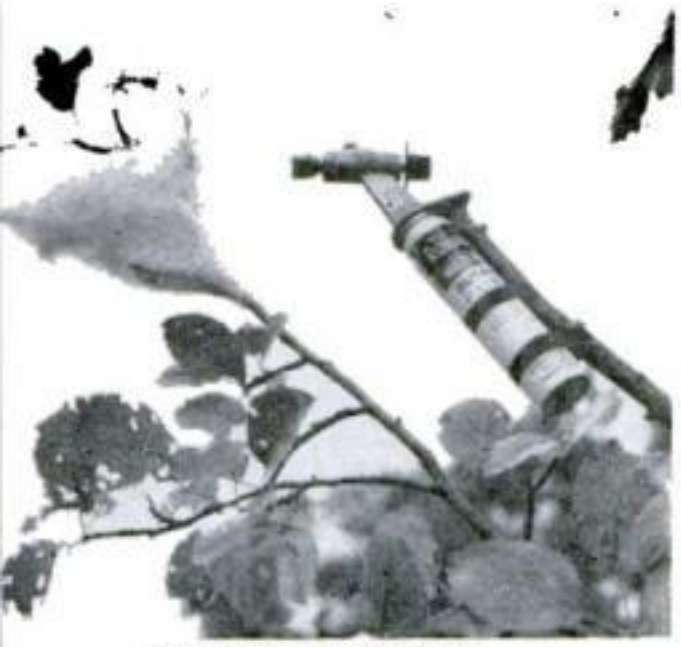
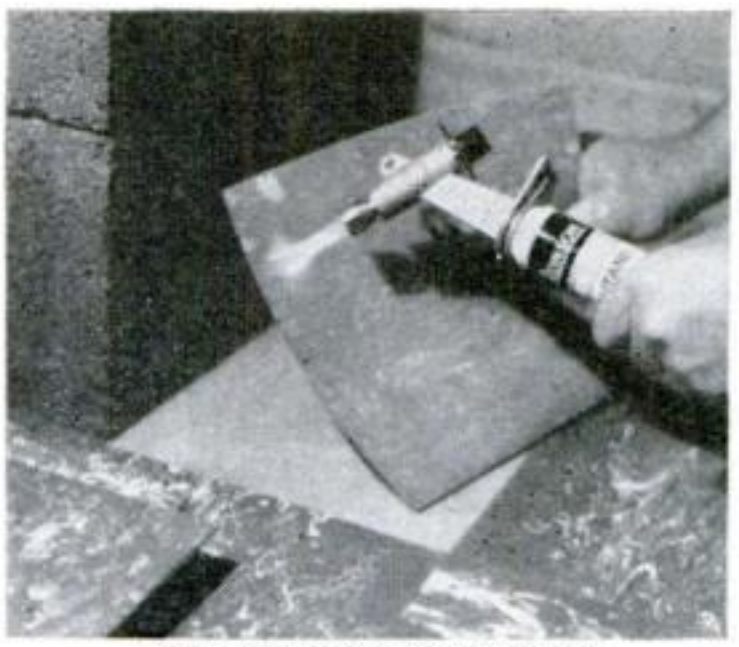


BURNS OUT WEEDS
AND CATERPILLAR TENTS.



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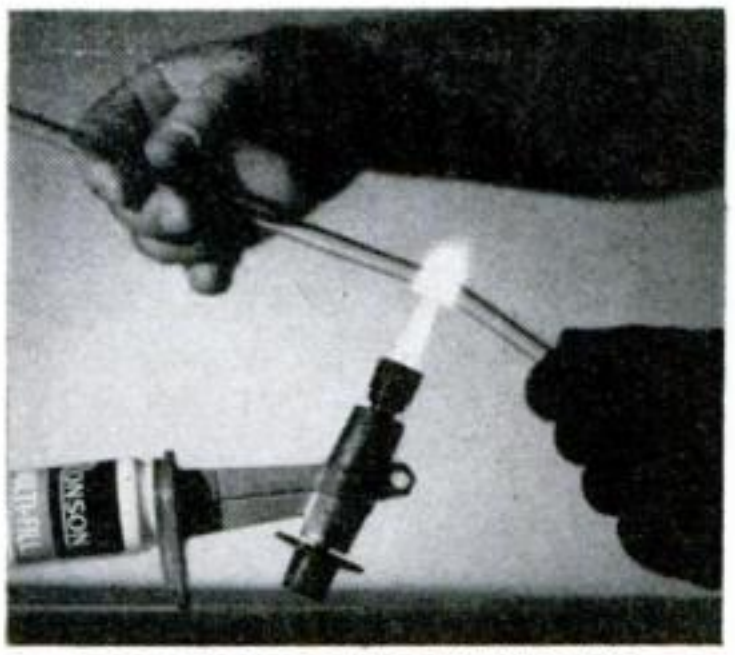

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(The Multi-Fill injector lasts for hours, but when it runs dry, you can buy a new one almost anywhere in town.)

And we developed an entirely new kind of torch head.

It snaps onto the Multi-Fill injector. You don't have to be a professional plumber to use it.

A fingertip knob controls the flame precisely. You get the bluest flame possible. The steadiest pinpoint flame. (The steadier and bluer the flame, the more intense the heat, the faster the job gets done.)

And you won't have to take this torch apart to clean it between jobs. It's completely self-cleaning. **It just won't clog.**

Now.

Where can you get your hands on the new Ronson Varaflame Torch?

Anywhere hardware is sold. The price, complete with large-size, 76 gram Ronson butane Multi-Fill injector, just $4.95.*

Isn't that a small price for this amazing torch?

RONSON®
Varaflame
Butane Torch

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Now...a motor that FOLDS!

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Smokey Yunick continued

eral overhaul since the car was bought new."—Joe Gallegos, San Antonio, Texas.

The two most common causes for smoking are oil rings that are not doing their job, or worn valve guides. Three lesser causes to look into are: a leaky oil-bath air cleaner, defective fuel pump, or plugged crankcase vents. Have a compression check made for ring leakage. Pull the heads to check valve-guide wear.

If you happen to live in a very dusty area, you may well need a complete engine overhaul.

►***"After my '63 Chevy Six sits a few hours, it bucks until warm. It does this at 20 to 30 m.p.h., but not if I speed right up to 40. The car has been in the repair shop five times under a two-year warranty. They put in plugs and points, adjusted the automatic choke and rebuilt the carburetor. Nothing helped. What's my trouble?"—Paul Stunek, Ellsworth, Pa.***

If this problem is associated with cool weather, better go back into that automatic choke again. Check the heat damper on the exhaust manifold to be sure it's working freely and that the spring is in good shape. If the ignition and carburetion are up to snuff, your Chevy should then give you buck-free starts.

►***"In cold, damp weather, my '61 Dodge Lancer starts up okay, but when I stop after a few blocks the engine dies. It has had a new distributor cap, plug wires, and a tune-up with no result. One mechanic labels it carburetor icing. The engine has always been difficult to smooth out, and even after much attention seems to retain its vibration. Any suggestions?"—Boris Gertz, Lexington, Mass.***

I doubt that the carb is icing, though it certainly sounds like carb trouble. When it quits like that, take a quick look at the carb, however, and see whether you can spot ice. If you can rule out ice, have the carburetor replaced or overhauled. Be sure it is set exactly to the specifications of the latest service bulletins. Also, check your choke system thoroughly, and your troubles should be over.

►***"My 1961 four-cylinder Pontiac experiences pre-ignition in warm weather, though***

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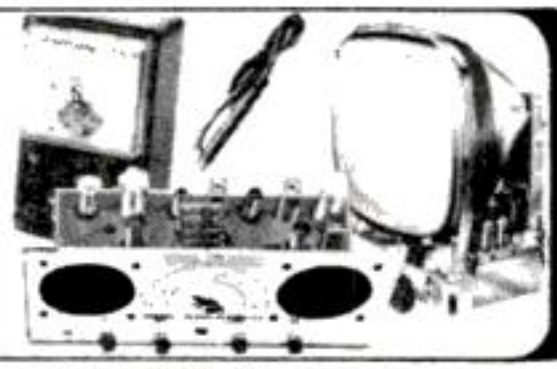

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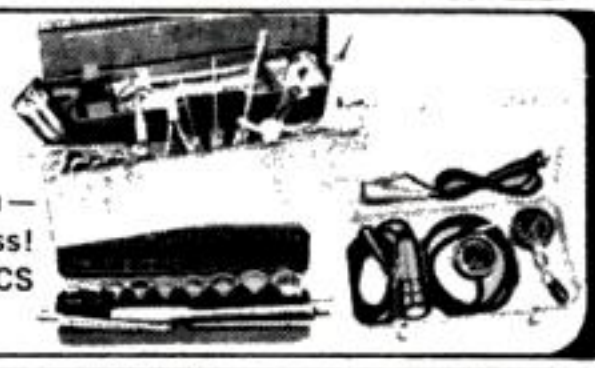

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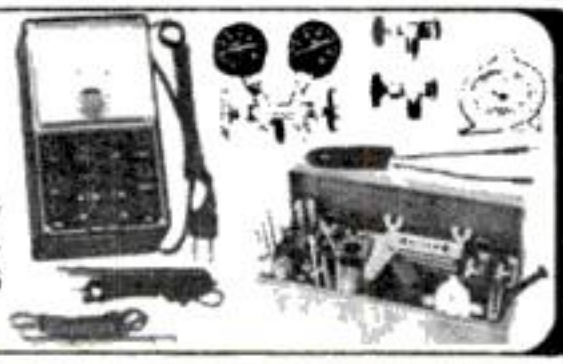

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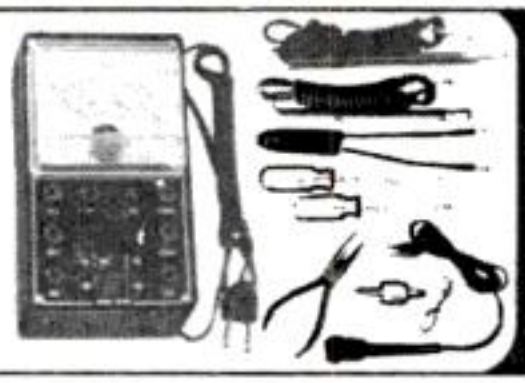

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I keep it tuned and serviced. After I cut the switch, it runs for a few more seconds, then rattles to a stop. Could this be due to cooling-system trouble or to deposits causing pre-ignition?"—Kenneth B. Curtis, Ayer, Mass.

Most of the trouble you're having is caused by the "shakes." The manufacturers put very soft engine mounts on four-bangers, and they don't idle very smoothly. Fuel shakes over into the manifold—enough to run the engine for a few seconds after cutting the ignition. The solution: When you turn the key off, push the throttle down, and the engine will stop.

►***"The power seems to fade out for a moment when I accelerate hard in my '63 VW bus, with the 1500 engine. I checked the points, plugs, timing, and accelerator pump. Also replaced the intake manifold and carb gaskets without much improvement."—Stan Rose, Madison, Wis.***

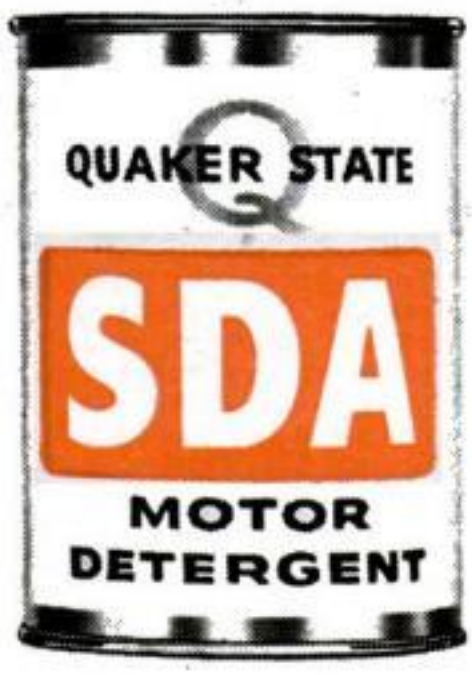
Three things could cause an engine to do this—it's too rich, too lean, or late. Your advance mechanism on this model is full vacuum. Be sure it's working on the specs. That will take care of the timing. For too-lean, be sure your accelerator system is putting out the proper amount of fuel. For too-rich, look into too high a float level, or too-big jets.

►***"How would steel exhaust-headers affect performance, engine life, and gas mileage of a '63 Chevy Bel Air with overdrive, 283-in. V-8, four-barrel carb, and twin exhaust? Would this be noisy with equipment mufflers?"—Wade Britt, Lovington, N.M.***

Steel headers from one of the good California makers would help. Engine life should be extended, mileage bettered. Noise shouldn't be any worse with good mufflers. Best consider good, low-back-pressure mufflers along with steel headers to get the most out of the deal.

Got a question on autos? Send it to:
"Say, Smokey—" POPULAR SCIENCE
355 Lexington Ave., New York, N.Y. 10017.
Not every question may be used. Questions cannot be answered by individual letters.

These are piston rings.



If they wear out, replacements may cost $175.

This helps prevent it for $1.75.

Fifteen ounces of prevention are worth sizable savings in repair bills if a "ring job" can be avoided. One can of SDA, Quaker State's Super Detergent Additive, in your car's crankcase can make the difference. SDA prolongs engine life by removing sludge and varnish, reducing engine wear, and preventing rust and corrosion. A clean engine gives more power on less gasoline, and extends battery life by starting fast. See your Quaker State dealer for fifteen ounces of SDA . . . and a cleaner, better-performing engine.

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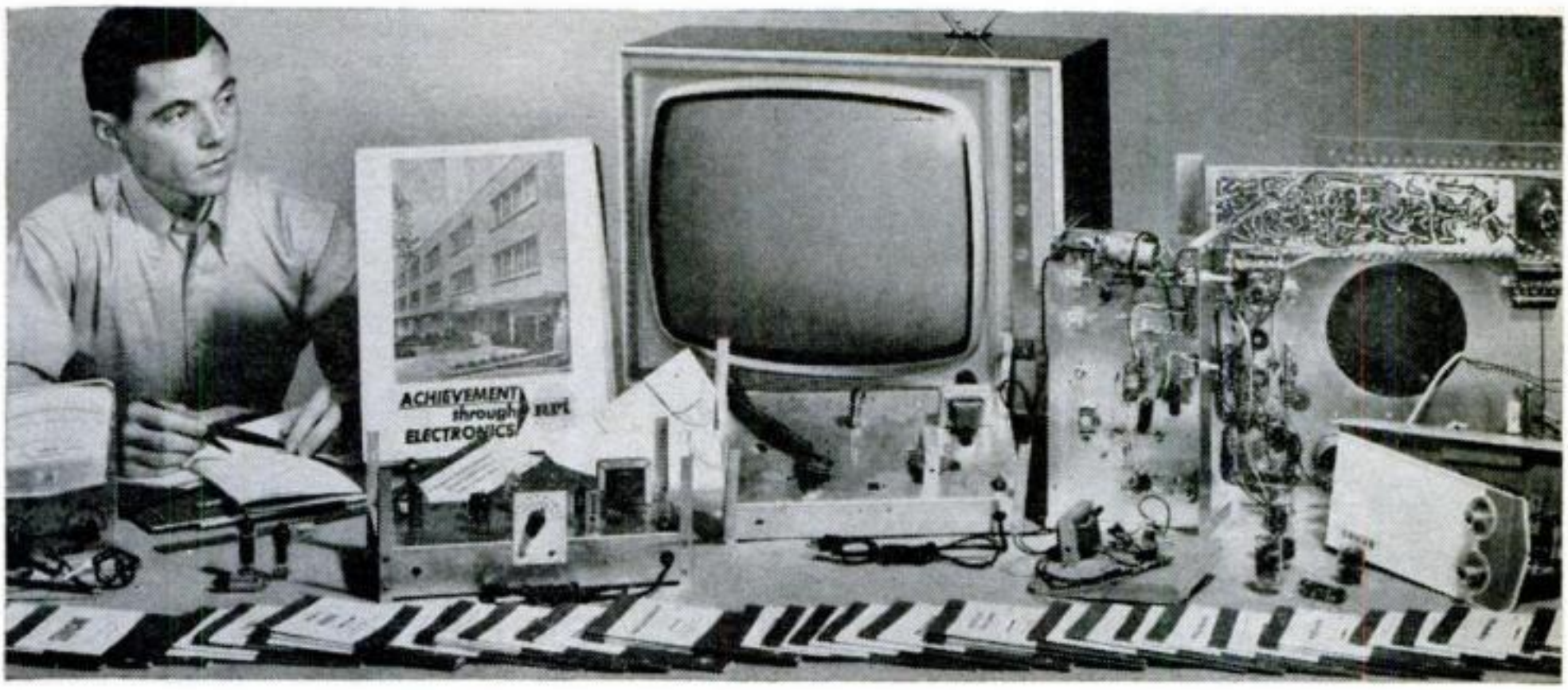

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F. W. COX, Hollywood, Calif., averaged $150 a month spare time while training, now has his own full time TV-Radio service business. ALLAN R. TOWNSEND, Topeka, Kan., is a missile officer at Atlas ICBM site, fixes radios and TV sets spare time. R. L. WOOD, Fargo, N. D., got his FCC license and is Master Control Engineer with KXIB-TV. J. J. JENKINS, San Diego, Calif., says his NRI training is priceless. He is Frequency Coordinator for the 11th Naval District.

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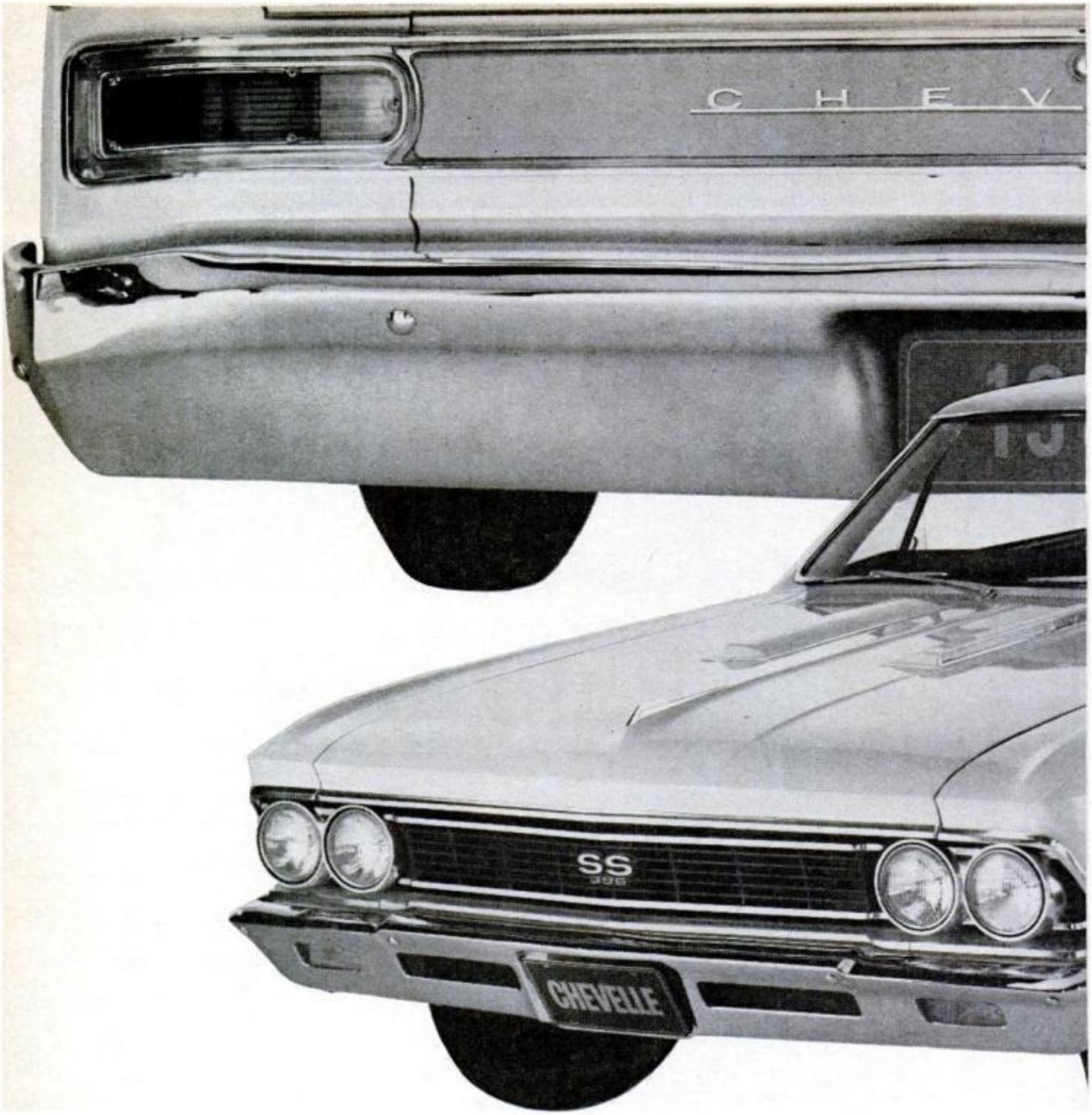

For 1966, a Chevelle with a quick set of reflexes: SS 396.

We refer, of course, to our already famous 396-cubic-inch Turbo-Jet V8. Rated at 325 hp, it's the motive force beneath the hood of every Super Sport 396. Unless you happen to specify the 360-hp version with a wilder cam. Torque in either case is over 400 lbs. ft.

We also refer to the car's remarkable handling ability, proof of which is the nearest twisting road. Stiffer springs and matching shocks are standard at all four wheels. So are red stripe tires and wide base rims, along with a heavier front stabilizer bar and a special rear axle. There's even a floor-mounted, fully synchronized 3-speed transmission and many other special items.

Need more convincing about this Chevelle's quick reflexes? Find yourself an SS 396 owner. If you can lure him away from the wheel long enough, get him to let you drive. Otherwise, see your Chevrolet dealer.

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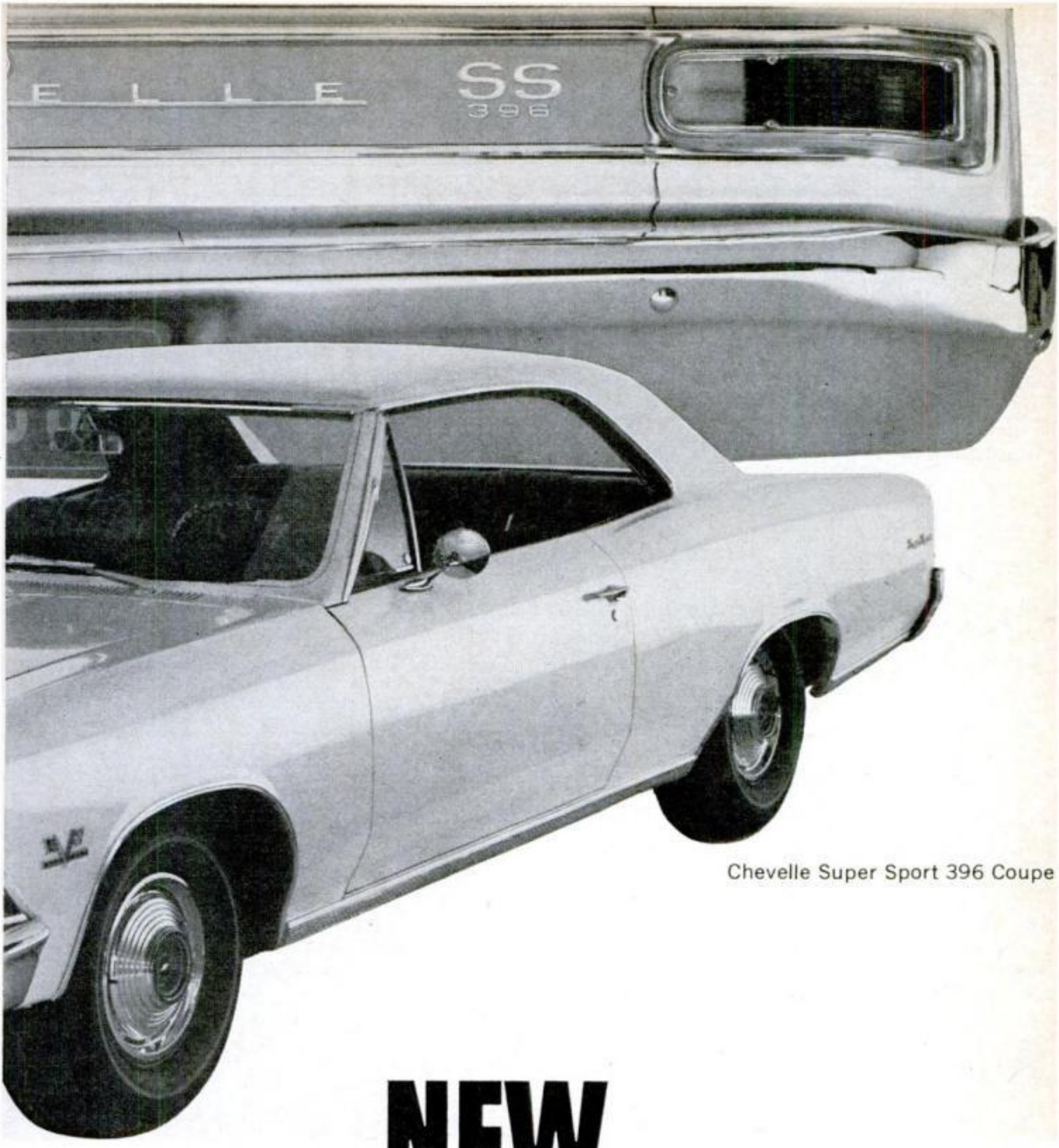

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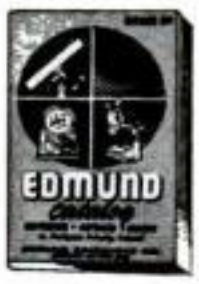

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Science Newsfront

By W. STEVENSON BACON

That electric automobile, electric boat, home power pack, and other devices—all operated by electricity-producing fuel cells—may be closer than you think. Already under development by GE for the consumer are a variety of advanced fuel cells using hydrogen or gasoline and air as fuel. Mistakenly blamed as a source of trouble during the flight of Gemini 5, the fuel cells in the spacecraft performed perfectly during the entire mission—despite a faulty oxygen tank. The cells themselves were designed to operate with an input pressure of 22 pounds per square inch according to GE spokesmen. The supply pressure never dropped below this critical level.

Greenhouse plants prefer soda over branch water, according to Dr. William Carpenter, floriculturist, and George Mowry, agricultural engineer, of Kansas State University. Leaf lettuce gently sprayed with carbonated water produced three times normal growth, while greenhouse chrysanthemums misted with mixer bloomed two weeks ahead of time. The carbon dioxide in the soda has the effect of accelerating plant growth.

The world's coldest, most isolated outpost will be established by the U.S. early next year at the heart of the Antarctic ice sheet, where temperatures are expected to reach 130 degrees below zero or lower. Called Plateau Station, the tiny outpost will be astride a 13,000-foot ridge on Antarctica's ice-mantled continental plateau, and will be 600 miles from the U.S. South Pole Station. Plateau Station, to be established by the National Science Foundation under the U.S. Antarctic Research Program, will be manned by four scientists and four U.S. Navy men.

A TV set you can hold in your palm may someday rival the legendary Dick Tracy wrist radio. Westinghouse engineers, using microelectronic techniques which allow many transistors and other components to be produced on a single piece of silicon no larger than a single old-fashioned transistor, claim to have produced the world's smallest TV receiver. Measuring just 21 cubic inches, the set uses a one inch picture tube. At present there are no plans to manufacture the set, which was built to demonstrate the company's progress with microelectronics.

An electronic wristwatch with no moving parts is another startling development in the field of microelectronics. The watch consists of four layers of semiconducting material incorporating transistors, resistors, capacitors, and other circuitry. The bottom layer is an oscillator which generates timing impulses; the next two layers are counting and switching units which translate the impulses into hours, minutes, and seconds, while the top layer is a display unit which lights electroluminescent figures corresponding to time. The watch, invented by Dr. Herbert S. Polin, will be produced by Solvil & Titus of Geneva, Switzerland, the circuitry by Texas Instruments, Dallas, Texas.

Automatic prescription eyeglasses that become sunglasses when exposed to bright sunlight, predicted in the February 1964, issue of PS ("Instant Sunglasses," page 84) will shortly be available. The new lenses are made of photochromic glass developed and sold by Corning Glass Works—glass which transmits as much light as ordinary glass in the shade (90 percent), but drops to 50 percent transmittance after five minutes in the sun (at 85 degrees). Chemical changes in the glass itself are triggered by the sun's ultraviolet radiation—the lenses gradually become clear again when the wearer moves into the shade or indoors.

Long used for swatting flies, newspapers and magazines may provide much more subtle means of insect control. Two Harvard biologists, Drs. Carroll Williams and Karel Slama, have discovered that many American papers contain a substance that prevents normal sexual development of certain insect species, destroying their ability to reproduce. Tested for such hormonal activity were 20 brands of paper towels, *The New York Times*, *The Wall Street Journal*, and several magazines. Significantly, European journals such as *The London Times* and *Nature* were hormonally inactive, as were other paper materials of European and Japanese manufacture. The scientists concluded that the balsam fir is the source of the hormonally active substance in American paper pulp.

A variety of aluminum-foil food containers—in the shape of pitchers, glasses, dishes, bowls, etc.—may soon be seen on supermarket shelves. With a forming technique developed by Alcoa, a blast of air forces the foil into a shaped cavity. The packages do not need to be washed or sterilized before being filled with such foods as instant coffee, tea, chocolate, dry soup mixes, or even doses of medicine.

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Science Newstront
continued

Cancellation of airline flights due to fog-bound airports may become almost a thing of the past. By seeding top layers of supercooled fog with dry-ice pellets at six Pacific Northwest airports last year, United Air Lines was able to keep 135 flights on schedule. It is now planned to extend the seeding program to nine additional cities including Detroit, Sacramento, Charleston, Buffalo, Chicago, Minneapolis, Denver, Omaha, and Des Moines. The technique is limited only by the fact that it does not work in combating warm fog found in coastal areas.

Cold welding—the mysterious phenomenon by which two pieces of metal fasten themselves together without human help in the cold vacuum of outer space—may prove to be a boon rather than, as at present, a dangerous nuisance which causes vital mechanisms and electrical switches to stick shut. Investigating the phenomenon for NASA, the National Research Corp. has found that almost any metal can be cold-welded to produce joints with strengths up to 10,000 pounds per square inch. If the process is perfected, space stations and other equipment could be welded in seconds in outer space with no equipment whatsoever.

An ultrasonic pencil that writes anywhere—under water, in sand or other loose material, or in outer space—will be produced by Ultrasonic Industries, Plainview, N.Y. The pencil, a rod of metal with a hard point, actually alters the molecular structure of paper, leaving a mark like a pencil. Held up to the light, however, the writing is transparent. Wires from the rod lead to a transistor ultrasonic generator operating at 20,000 cycles per second. The pencil may be used for charting temperature, rain, and snowfall at remote weather stations as it requires no service. Since the writing never fades and cannot be altered, the pencil would also be useful for permanent signatures on bank notes and other important documents.

Steel armor plate for Army helicopters that shatters bullets to bits and then swallows them is being produced by the Aeronutronic Division of Philco Corp. The armor is made of two types of steel bonded together during early forming. The front face of the armor is very hard, shattering a bullet on impact; the back face is softer, dissipating the projectile's remaining energy by absorbing it.

The first "natural" neutrinos, produced by the interaction of cosmic rays with the earth's atmosphere, have been discovered in the world's deepest laboratory located 10,492 feet down in a gold mine near Johannesburg, South Africa. Neutrinos are strange nuclear particles which

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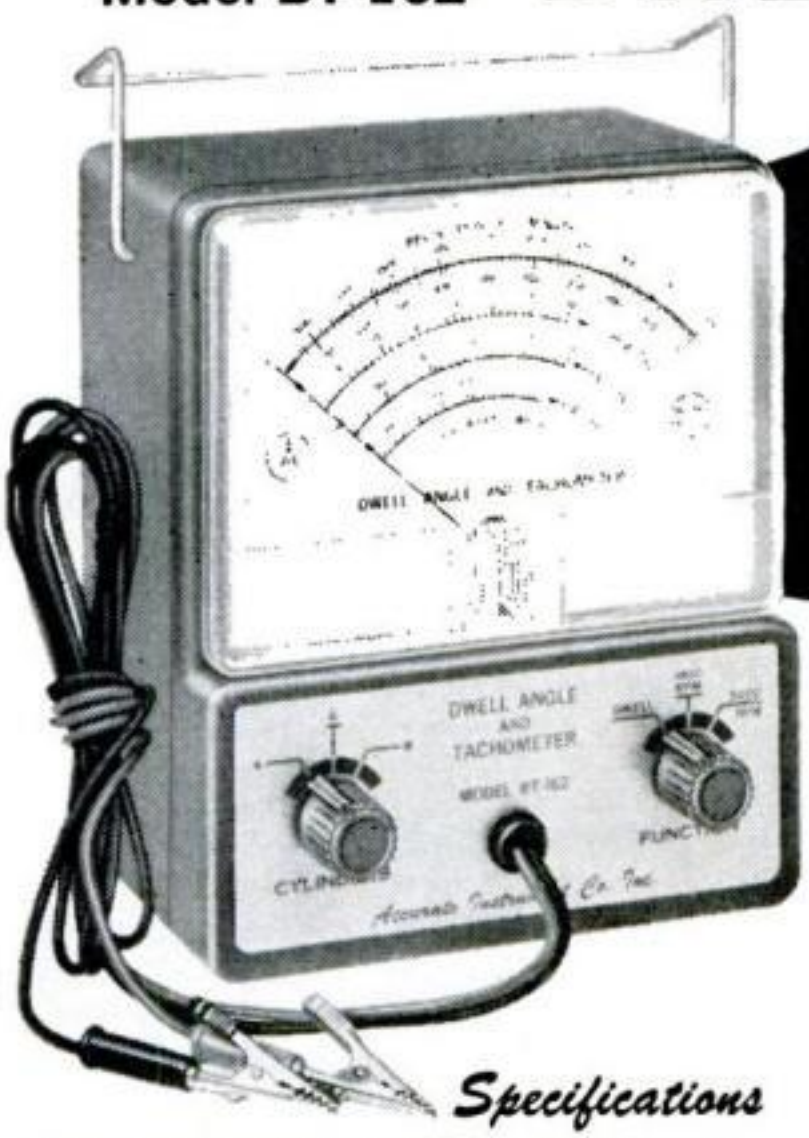

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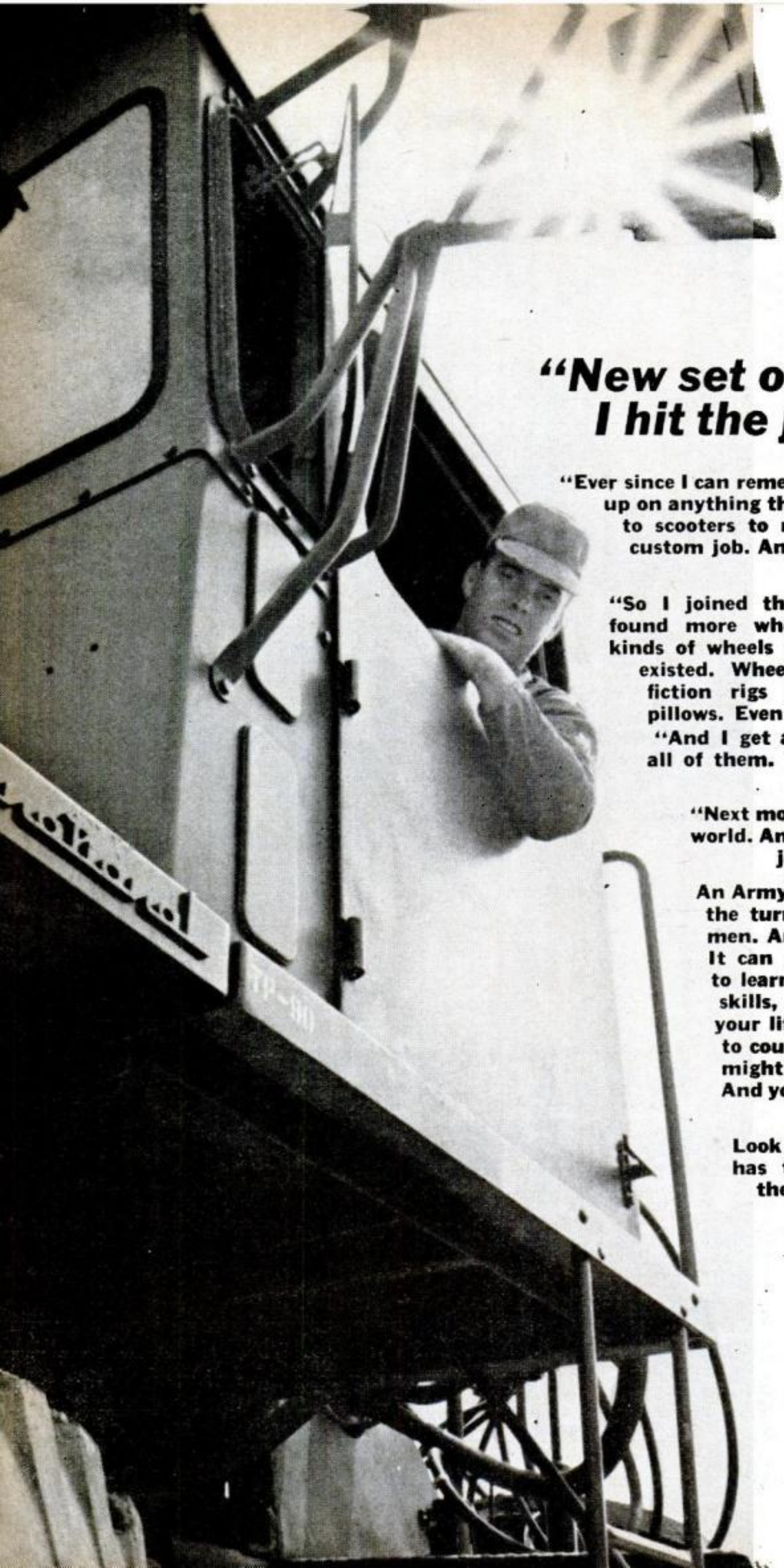

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have no mass and no charge—they can be detected only on rare occasions when they interact with the nuclei of other atoms.

Since other types of radiation particles interfere with the detection of natural neutrinos on the earth's surface, an AEC-sponsored research team from Case Institute of Technology and the University of Witwatersrand, Johannesburg, selected the gold-mine location. Only the neutrinos penetrate the deep natural shield of the earth's surface. They were recorded in the underground laboratory by a 20-ton liquid scintillation detector, the largest yet operative.

Human hairs may replace fingerprints as the prime means of tracking down suspected criminals. The new technique is an extension of one described by PS in August 1963 ("Atomic Fingerprints: Our Newest Weapon in the War on Crime," page 55), human hairs found by police are placed in an atomic reactor. The radioactive hairs are then analyzed—a single hair, for example, might show traces of elements found only in a certain locale, elements from the scene of a crime, etc. Research is being done in the U.S., Canada, and Great Britain.

Two "cold" stars have been discovered by scientists using a unique new 62-inch infrared telescope that measures "heat." The two stars, one of which may have a surface temperature as low as 800 degrees F, were discovered by Professors Gerry Neugebauer and Robert B. Leighton of Caltech under the sponsorship of NASA. The stars are thought to be among several thousand such bodies which radiate most of their energy in the infrared region and are, consequently, difficult or impossible to see with ordinary telescopes.

The new infrared telescope—located on Mount Wilson—uses a supercold detecting system kept at minus 328 degrees to eliminate the effects of heat energy radiated by objects in the vicinity of the instrument. A concave aluminum-coated plastic mirror reflects the faint infrared rays onto detectors of lead sulphide and silicon, changing their electrical resistance and causing them to amplify a current flowing through them. A "heat" map of the sky is produced by scanning with the telescope.

Trouble-shooting engines "by ear," long the mark of a good mechanic, is coming into its own: The U.S. Army is now studying a similar method for spotting trouble in machines of all types—including some that don't generate any noise. Known as mechanical signature analysis, the GE-developed technique involves sophisticated listening equipment and special sound generators to inject vibrations into passive machines. ■ ■

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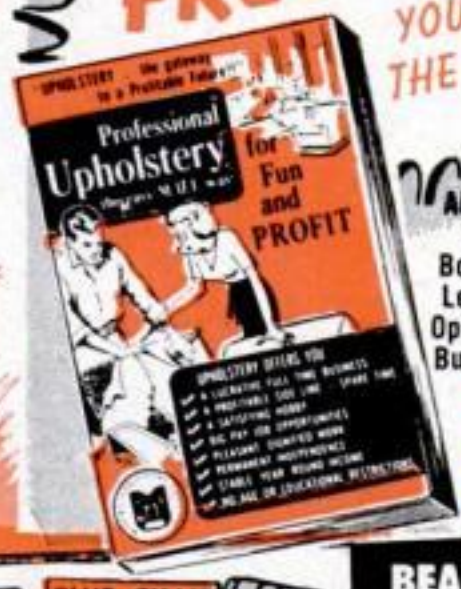

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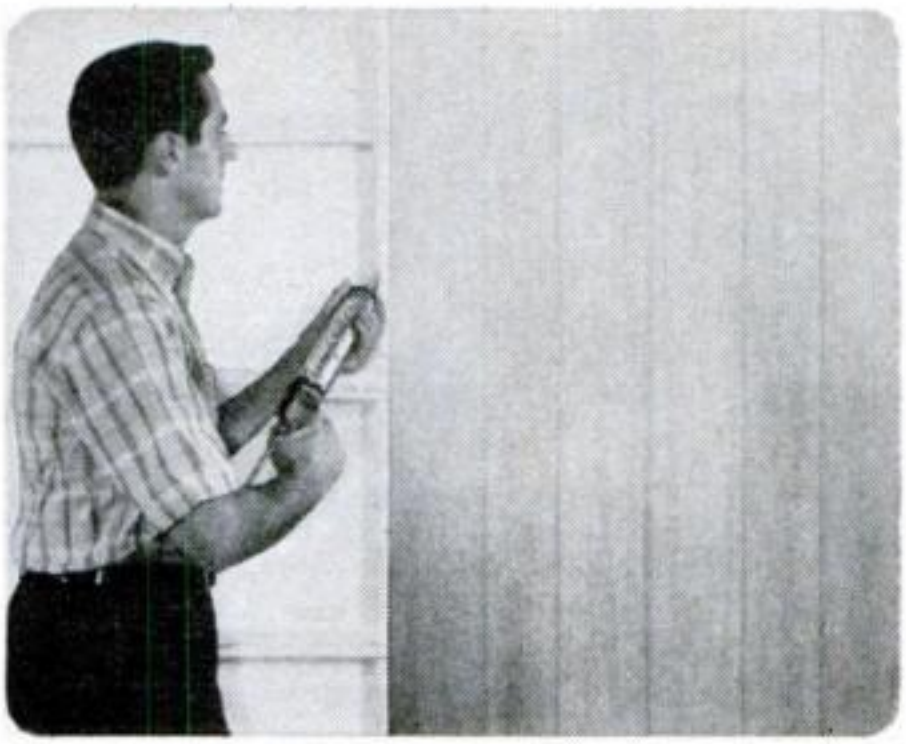

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Detroit report...

A CHRYSLER ENGINE WILL POWER a new four-wheel-drive passenger car built by Jensen Motors in England. The TorqueFlite transmission is hooked up to a Ferguson drive, which incorporates a front/rear differential. A duplex clutch unit coupled to this differential lets the front wheels run up to seven percent faster than the rear ones, while rear wheel "spin" is limited to about four percent.

Why four-wheel drive? It assures traction on slippery roads and better adhesion on turns. The car will not slide or drift on high-speed cornering. Best of all—it will stop quicker with full retention of directional control and less risk of wheel locking. But four-wheel drive is expensive, and may be restricted to a few high-priced cars. Jensen has been making fast luxury cars since 1936. Harry Ferguson Research developed the drive system and has demonstrated its advantages on many racing cars (Ferguson P-99, Felday, BRM, and Novi).

Lincoln-Mercury's Cougar is expected in the spring of 1966. It will be a roomier and heavier car than the Mustang, with fastback styling. The 289-cu.-in. Comet V-8 will probably be the standard engine, but power options might go as far as the 427-cu.-in. V-8. That will make it the hottest Ford on the road, next to the $16,250 Ford GT-40.

Dodge's Charger will be announced in a few weeks. It will be a larger car than first expected, as it will be built on the 121-inch Polara wheelbase and not on the 117-inch Coronet wheelbase. It will be the biggest pure fastback in the business, sharing power train and chassis options with the other full-size Dodges.

The racing successes of the Chaparral and the McLaren-Olds have convinced Europeans that automatic transmissions really are better. The Chaparral transmission is based on Powerglide parts, rearranged and rebuilt by Jim Hall, and Bruce McLaren's Olds-powered car has the Ferguson-Teramala transmission (with reduction gearing interposed between the engine and the torque converter).

Now Borg-Warner's British branch is working at capacity to provide enough automatics to satisfy Jaguar, Daimler, Rover, Rootes, Aston Martin, BMC, Ford of England, Triumph, and Volvo. German Fords come with Taunomatic (a small Ford-O-Matic). Vauxhall and Opel are available with GM's Powerglide. Mercedes-Benz builds its own transmission (with hydraulic couplings instead of torque converters); so does Rolls-Royce. BMW uses the new three-speed ZF torque-converter transmission. And for some time now, Ferrari has been testing various automatic transmissions.

Growing use of plastics. The optional fiberglass hoods used by Comet and Fairlane are supplied by General Tire & Rubber Co., who developed matched steel molds, raising mold life to 50,000 units (compared with 500 to 600 in the cheapest molds). They still have their problems: mainly rough surface finish and surface cracks at sharp angles. The new Pontiac Tempest grille is made of an acrylonitrile-butadene-styrene compound molded at GM's Ternstedt Division. With Tempest production running at the 300,000-a-year level, manufacturing speed is critical. Molding takes about two minutes per unit, so tooling is a big investment. Other problems: shrink marks and handling damage.

Radial-ply tires have a hard time gaining acceptance in the auto industry. A Barracuda recently won a major rally on Michelin X tires (with steel breaker plies), and Chrysler Corp. is experimenting with Firestone radial plies (fiberglass breakers). Pontiac started off with a series of tests on Pirelli Cinturato a long time ago, now runs some test cars on B. F. Goodrich radial-ply tires, and is still unconvinced.

The industry as a whole is exaggerating the low-speed harshness and noise problem of radial-ply construction.

I have driven a Tempest Sprint six with Goodrich radial-ply tires, and the improvement in steering response and cornering stability alone was enough to convince me that radial-ply tires will win—eventually.

Jan P Norbye
Automotive Editor

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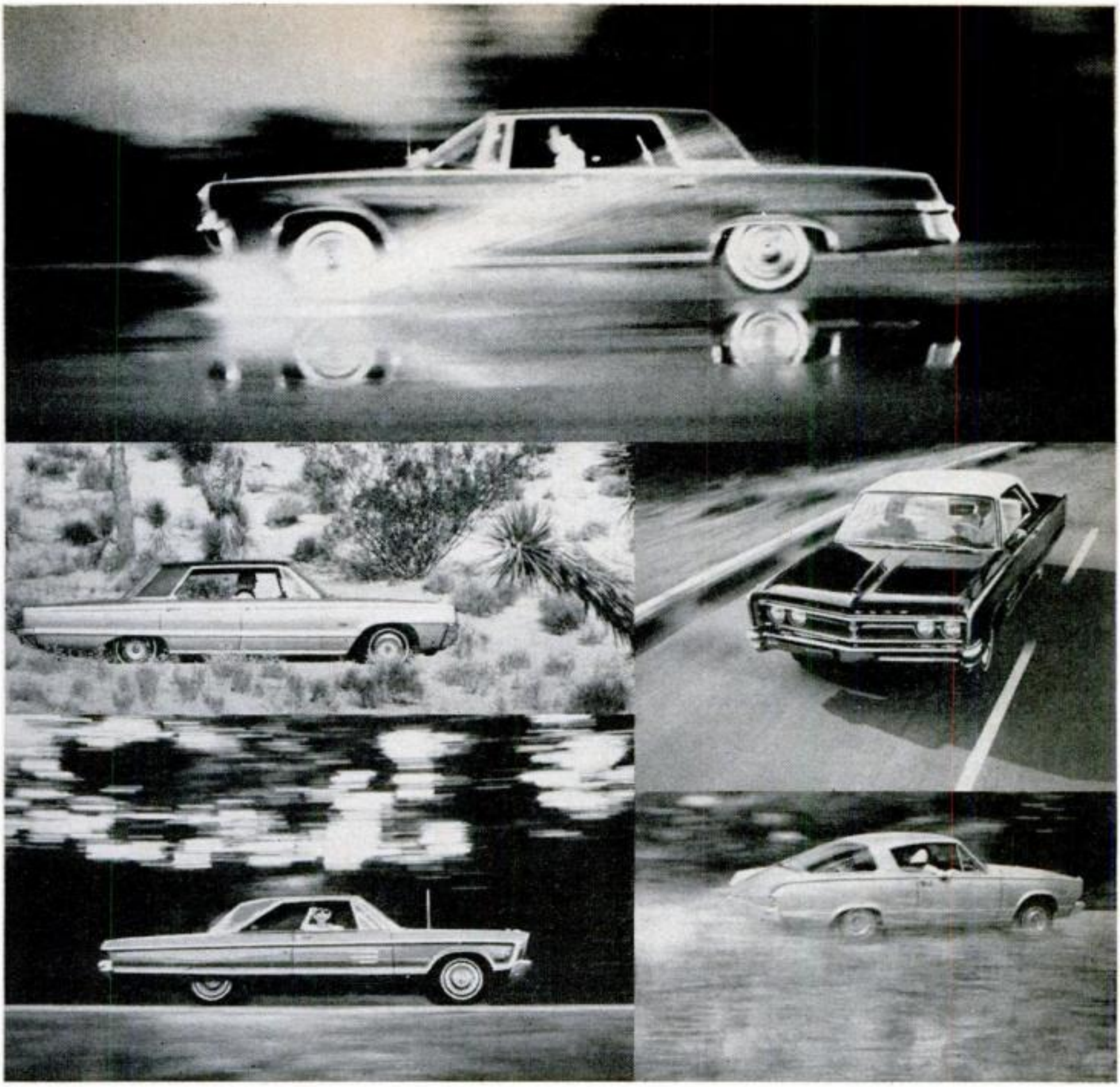

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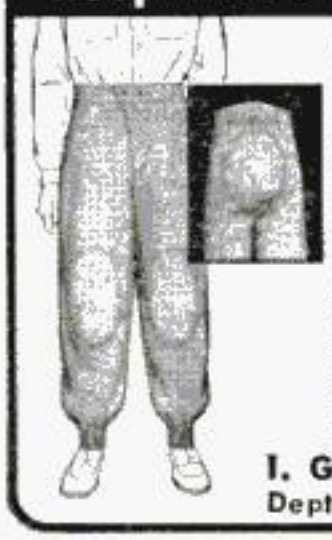

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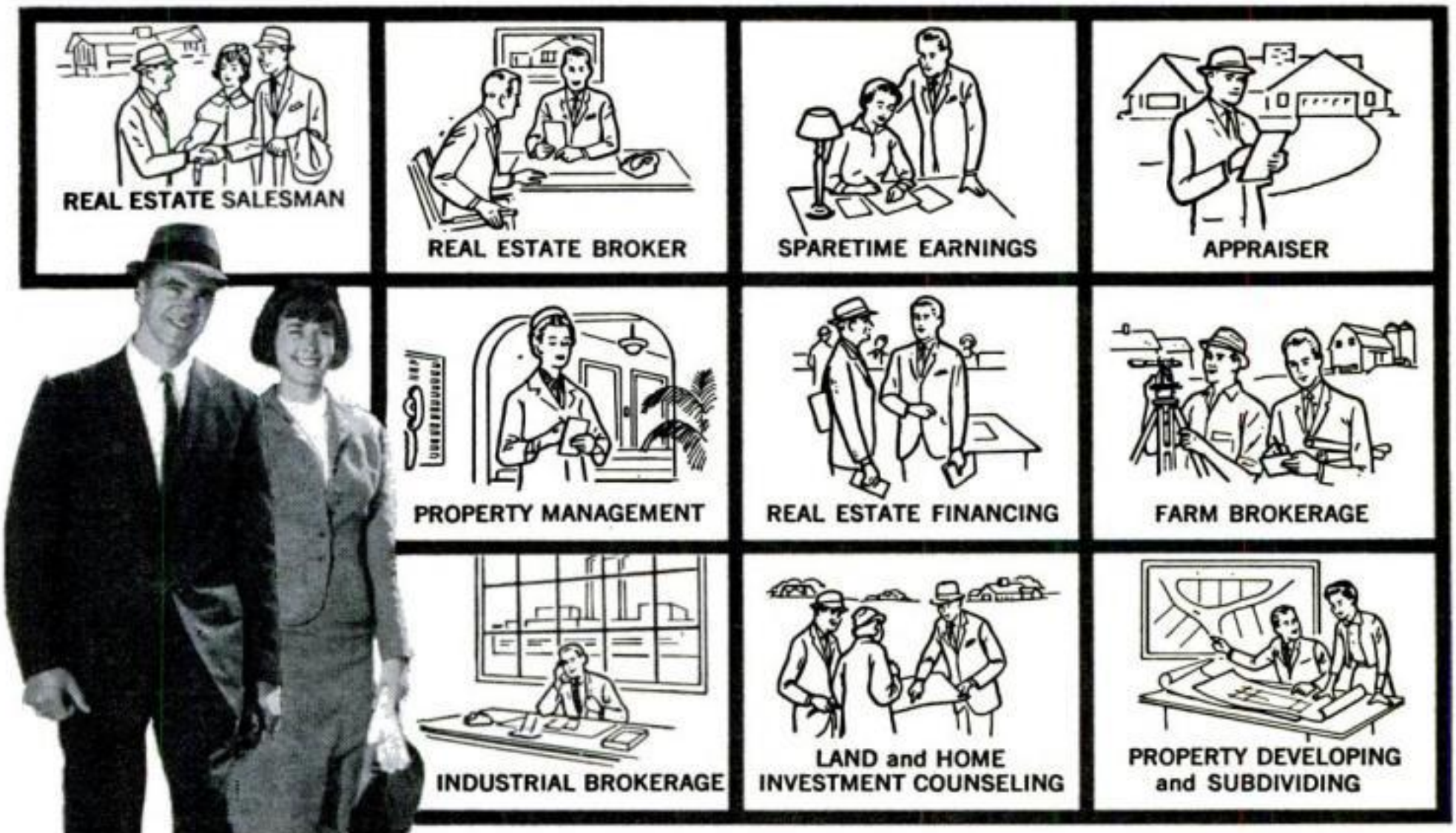

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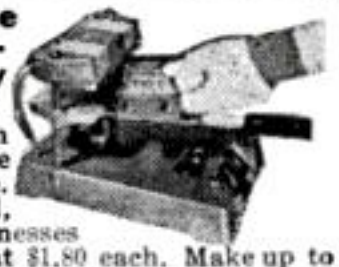

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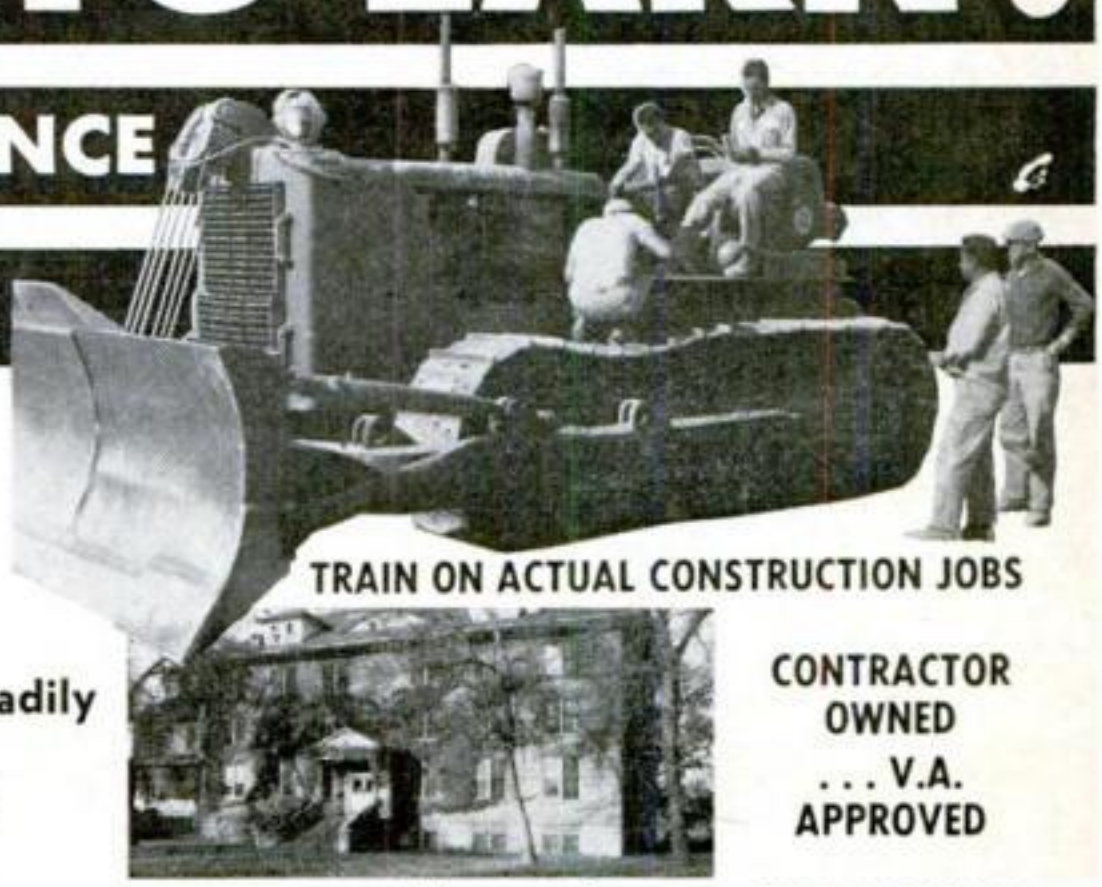

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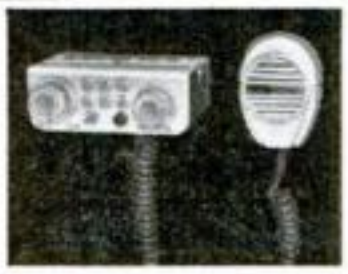

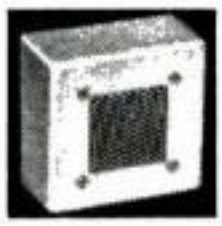

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PS readers talk back

[Continued from page 8]

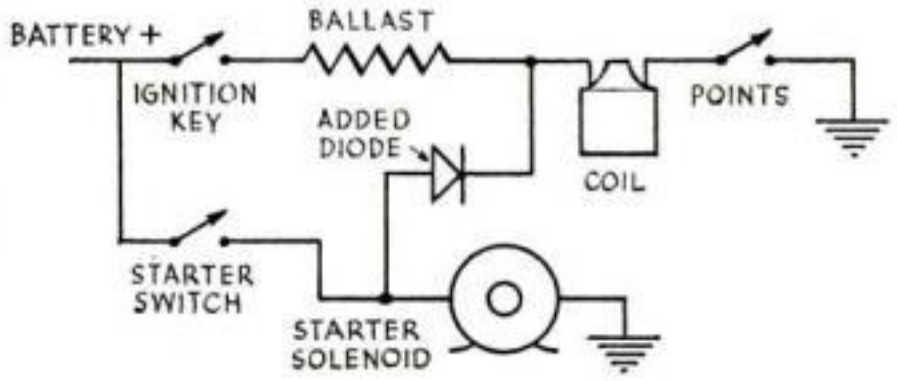
is more efficient in the smaller displacements since it fires more frequently, offers more usable horsepower, and has more spirit than a four-stroke." Any comment?

D. Leigh, Berlin, Wis.

A small two-stroker can deliver more power for its weight if it is designed for high r.p.m., but the four-stroke will use less fuel for the same power output.

Got Cold-Starting Trouble?

Bill Kingston's improvement for hard-starting cars ["PS Readers Talk Back," Sept.] still runs to too much junk to hang on a car. My fix for a balky Renault will work on the Detroit critters, too:



Use an alternator diode (polarity to suit battery installation) from the starter solenoid to the hot side of the coil to bypass the coil resistor. This is the no-fuss-no-muss fix. It makes lots of lightning every start and gives automatic disconnect after starting. Diodes make fine switches.

Walt Stevenson, Independence, Mo.

Help-Wanted Department

Before winter, I put the recommended amount of dirt cutter and antifreeze into my window-washer tank. Now the paint around the windshield is being affected. Before another winter rolls around, can anyone suggest an additive to perform the necessary functions, yet not affect paint?

Michael Barish, Scarsdale, N.Y.

Head-Spinning Questions

Ever held a hammer by the handle, flipped it, and caught it by the handle again? The head always reverses itself. It seems every object flipped in this manner does the same thing! Why? I've tried to follow the direction of rotation, but could never be certain if it was always a clockwise or counterclockwise motion. Is it one or the other; and, if so, would a left- and a right-handed person obtain the same results? Is the head-spin caused by the handle's motion around it, is it caused by some particular motion of the individual's hand, or is some law of physics the answer? Any theories from other readers?

Edward R. Holtz, APO, N.Y.

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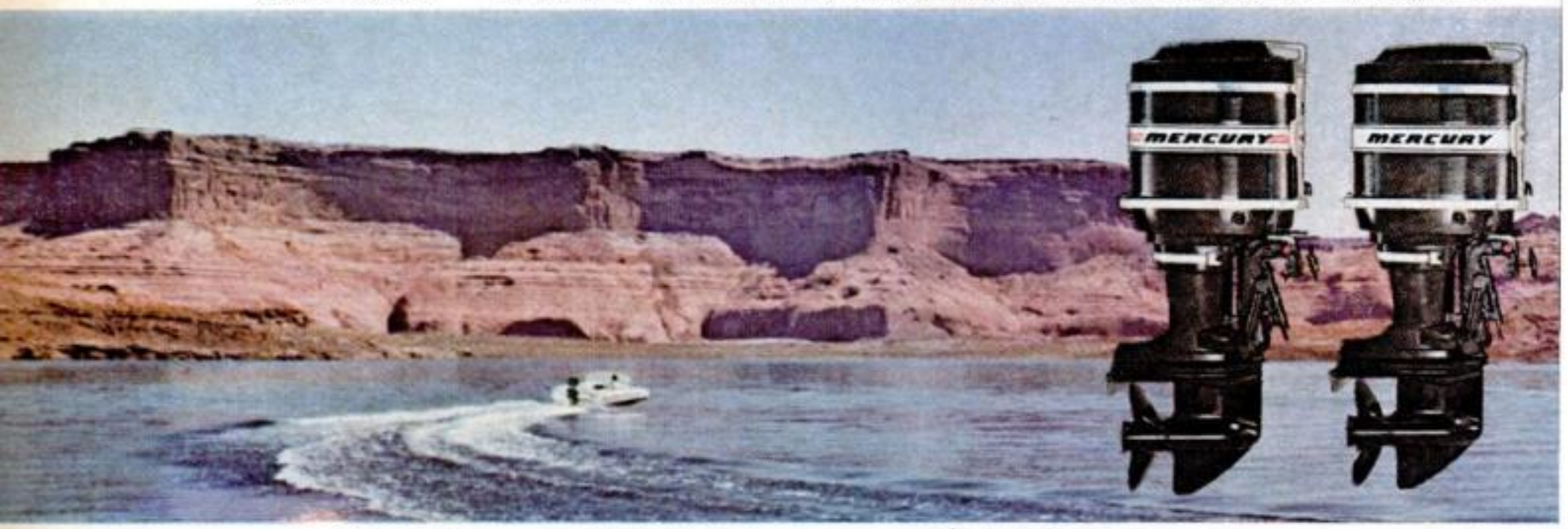

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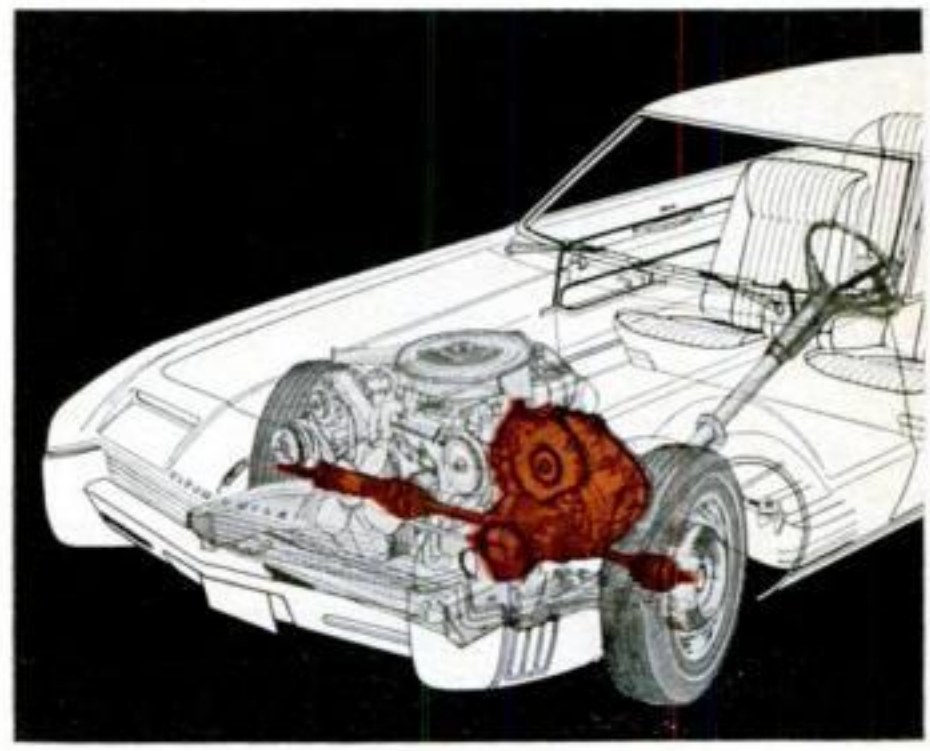

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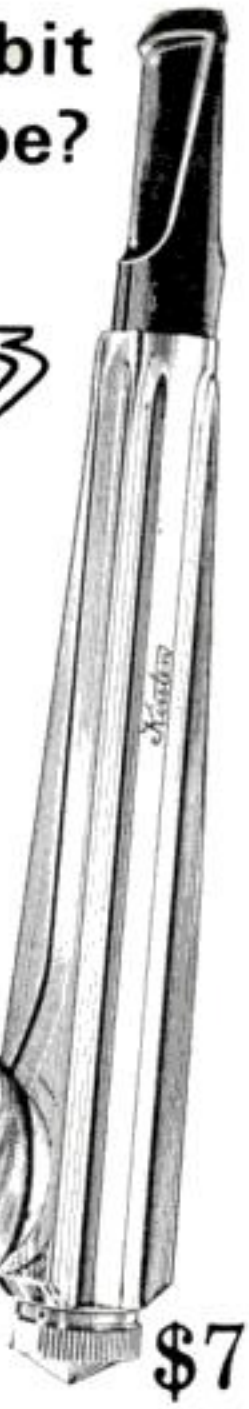

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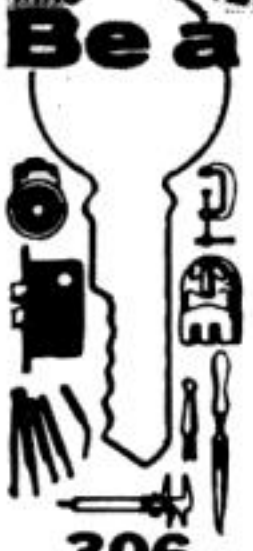

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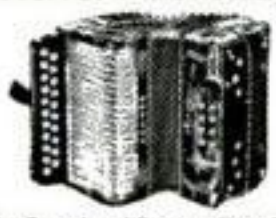

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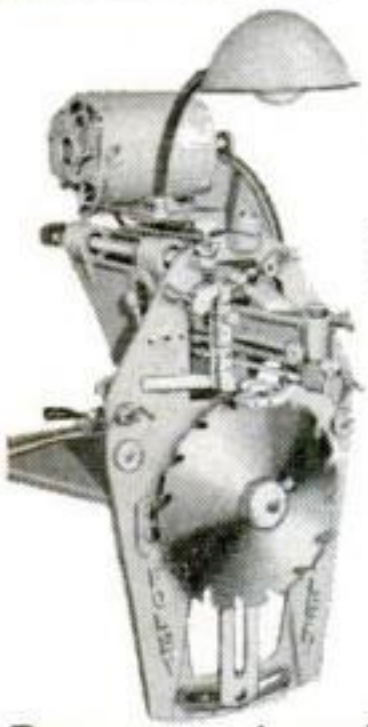

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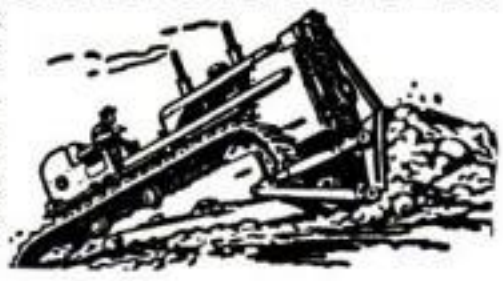

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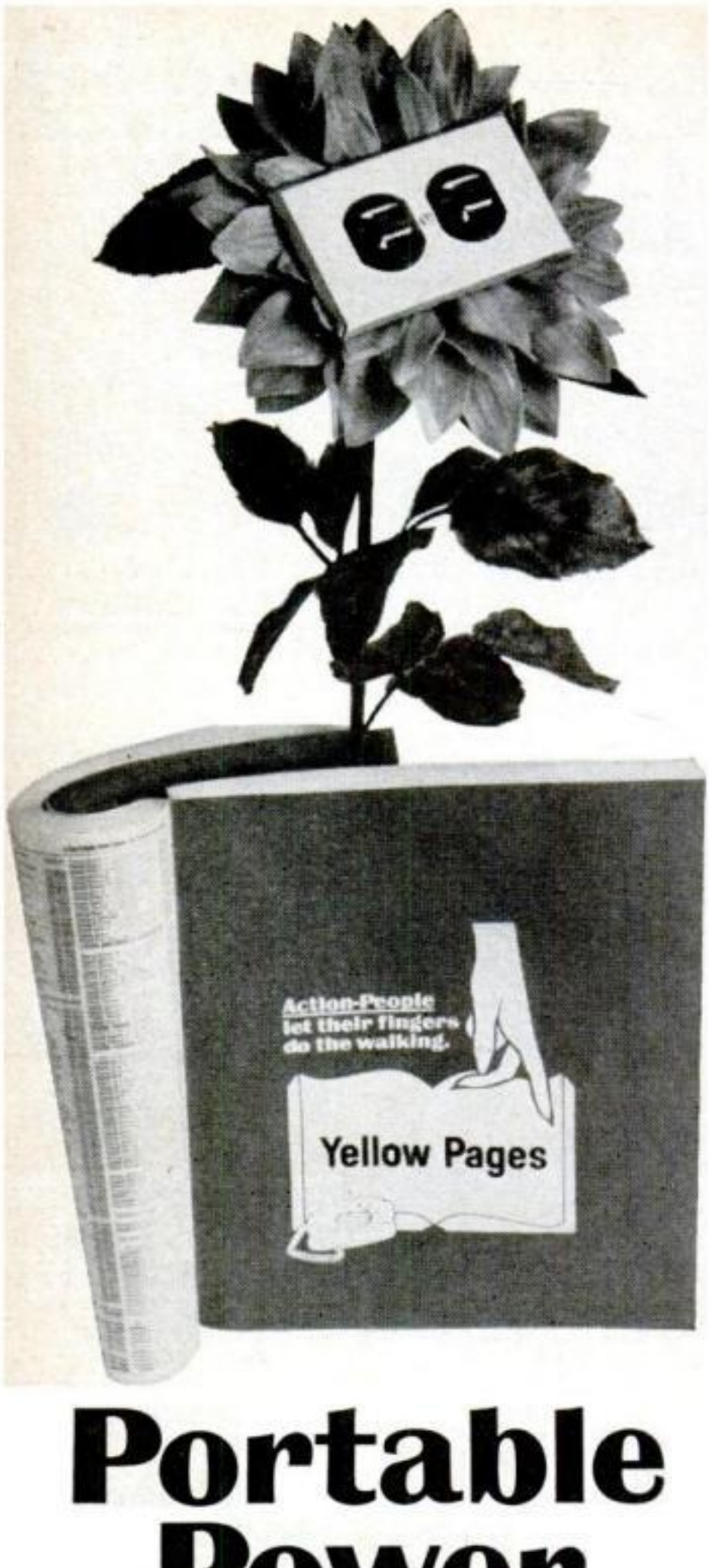

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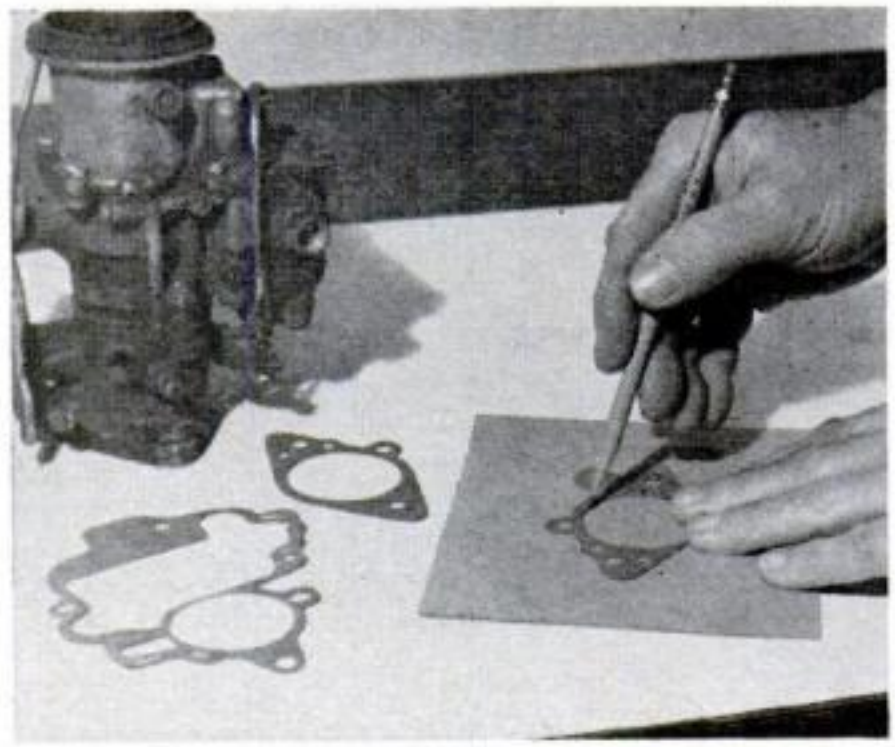

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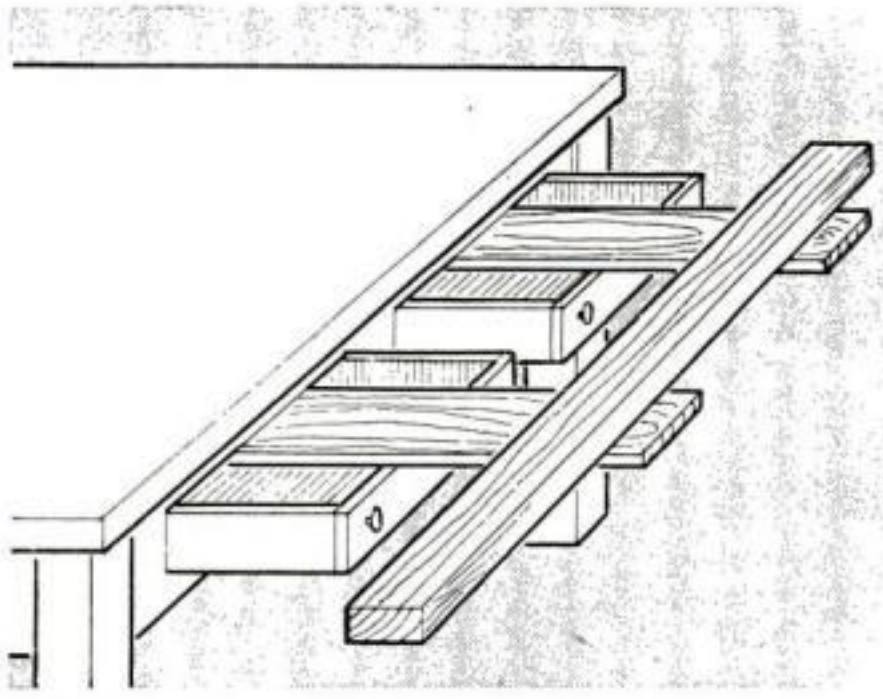
When installing a new paper gasket, keep in mind that the next time this job is done a new replacement just might not be available. It takes only a minute to trace out the pattern and file it away.—*Herbert Y. Moon, Orient, N. Y.*

►►► When pictures, mirrors, or ornaments are suspended from ceiling moldings, I find that the ordinary wire or cord is objectionably noticeable. So I use nylon fishing leader instead. It's strong, durable, and you can hardly see it against a neutral background. —*F. W. Chesson, Waterbury, Conn.*



What to do when you lack sawhorses

When my sawhorses are already in use, I find the arrangement shown above an excellent emergency measure. Put a board into each of the partly opened top drawers of the bench and rest the work on these.—*R. B. L. Snow, Port Carling, Ont.*

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WIN! the B&D Black & Decker® DREAM WORKSHOP

Here's a handyman's dream come true! You could be the winner of this marvelous Dream Workshop. It's a duplicate of the House of Good Taste workshops seen by millions at the New York World's Fair. It's chock-full of Black & Decker and DeWalt power tools and accessories, plus all the hand tools any workshop needs. There are 1,149 other great prizes, too. Just fill out the entry form attached and take it to your Black & Decker or DeWalt dealer for validating. If the entry form has been removed, your dealer has additional ones. Enter often as you wish. Also, he can show you the Black & Decker power tools you would want for your Dream Workshop—winner or not. Black & Decker, Towson, Maryland, 21204

GRAND PRIZE

"DREAM WORKSHOP" (PICTURED BELOW) INCLUDING ALL THESE POWER TOOLS—

DeWalt 10" Deluxe Power Shop with 14 accessories • New ⅜" Deluxe Variable Speed Drill with bench stand • Black & Decker ¼" Cordless Drill with Power Pack and Charger New Professional Jig Saw Kit with 15 extra blades • 7¼" Deluxe Circular Saw with case, cut-off guide and 5 blades • New Dual Action Finishing Sander with dust collector and 30 abrasive sheets • Professional Belt Sander • 11-piece Router Kit • ½" Reversing Drill with drill press stand • Cordless Hedge Trimmer with Power Pack and Charger • and the Black & Decker Deluxe Lawn Edger & Trimmer with 100′ extension cord. Also included are 40 drill accessories, 40 hand tools and all the Dream Workshop cabinets and wall units you see in the picture (designed by Popular Science for Black & Decker).

1149 OTHER GREAT PRIZES! 11 2nd Prizes • 88 3rd Prizes • 300 4th Prizes • 750 5th Prizes

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Announcing America's Total Performance Cars for 1966

1966 Ford

1966 Fairlane 500 XL Hardtop

1966 Fairlane

Fairlane re-invented . . . still the rugged, reliable family car, but with all-new performance for '66! What's new? New models—13 in all. New power. A whole new look! New Fairlane convertible, XL, GT and GT/A series. New paneled Fairlane Squire. Fairlane is a family car —for very lively families!

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1966 Ford LTD 2-door Hardtop

Quiet Quality, Powered by Ford! Its quiet says quality and "Powered by Ford" says performance! Here's the news in Ford for '66: new optional Stereo-sonic Tape System • new front power disc brakes • new Magic Doorgate for wagons • new 7-Litre high performance series • 19 lively, luxurious new '66 Fords to choose from—drive one today!

1966 Falcon Futura Sports Coupe

1966 Falcon

America's Economy Champ—now on its third million—with a sporty new look! Falcon '66 is the strongest, roomiest, best-looking, smoothest-riding compact car we've ever built . . . and still Falcon-low in price!

1966 Mustang Hardtop

1966 Mustang

If you thought we couldn't improve on a winner—try Mustang '66! The changes are subtle but significant. Bright new grille. New Stereo Tape option. Plus all the features that made Mustang a record-breaking success.

AMERICA'S
TOTAL PERFORMANCE CARS

FORD

MUSTANG · FALCON · FAIRLANE · FORD · THUNDERBIRD

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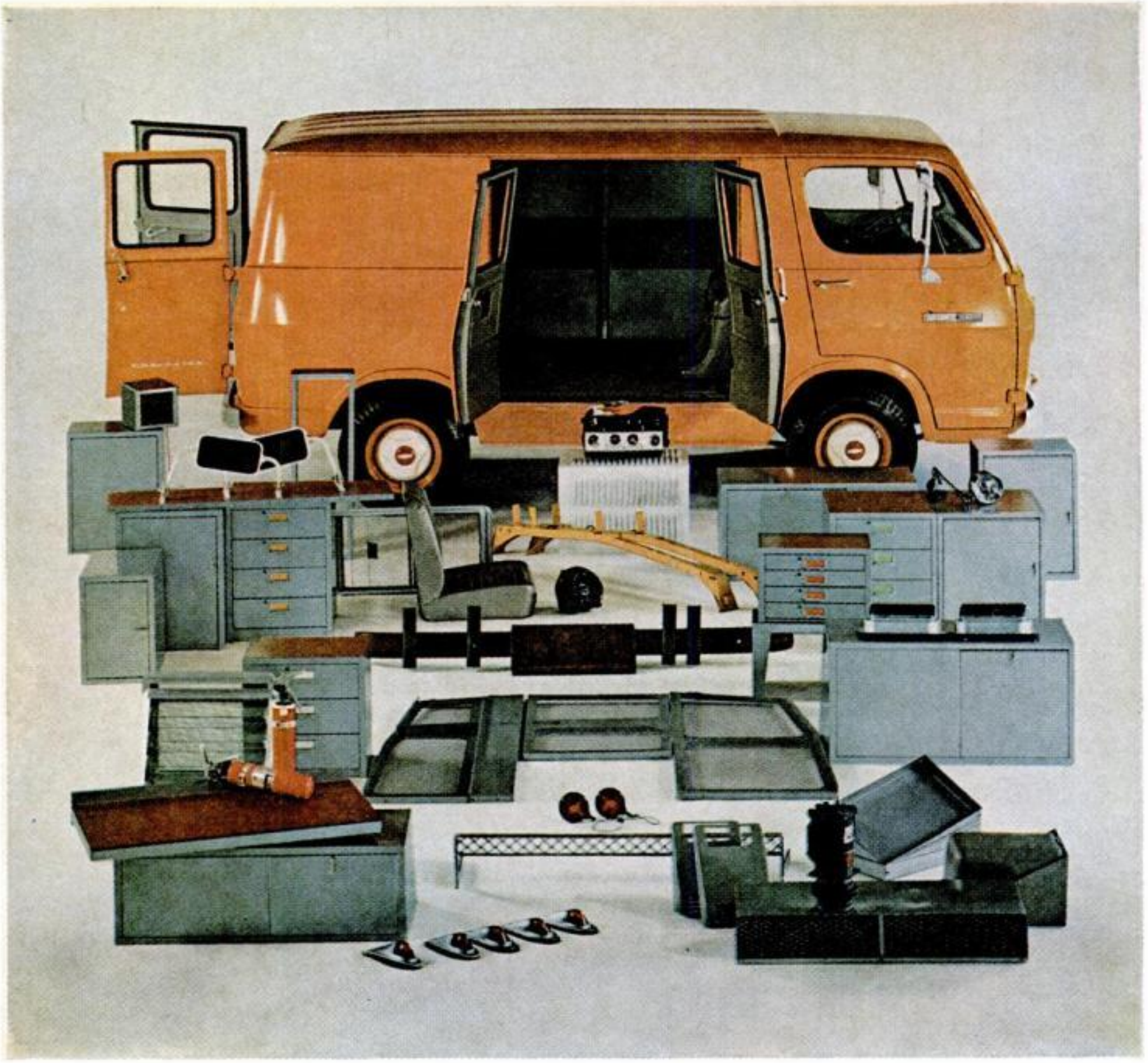

Customize a low-cost Chevy-Van for your job!

Pictured above are just a few of the more than 80 special installations that can now be ordered through your Chevrolet dealer. Now you can equip a money-saving Chevy-Van for your kind of work!

CHEVROLET

Order cabinets or bins, shelves or racks . . . special windows, floors or partitions, a refrigeration system or extra ventilation or more seating comfort. And much, much more. You name it! Get just what you need for your delivery work—and take advantage of these Chevy-Van virtues: low initial cost and upkeep, big 211-cu.-ft. load space, flat floor, big doors, to name just a few. See your Chevrolet dealer. . . . Chevrolet Division of General Motors, Detroit, Michigan.

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Popular Science
REG. U.S. PAT. OFF. MONTHLY

PS Exclusive: A senator's bold plan to create a National Highway Safety Center—a $150,000,000 program for safer cars and roads

WHY CAN'T WE MAKE CARS SAFER?

By Senator Robert F. Kennedy

Nearly half of the 47,000 Americans who die in automobile accidents each year might survive if they were riding in cars that were properly constructed for survival.

This surprising fact should shock the conscience of all of us who have prided ourselves on American engineering and technical com-

CONTINUED

Sen. Robert F. Kennedy discusses auto safety with GM's board chairman Frederick G. Donner at a recent Senate hearing.

Newsweek photo by Rowland Scherman

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RFK's goal: Save the 43 percent of crash victims that could survive in safer cars

petence. Even though traffic-safety experts tell us that the biggest cause of auto fatalities is driver error, the fact remains that many of the victims die under survivable conditions. Elmer Paul of the U. S. Public Health Service Accident Prevention Bureau estimates that if our cars were built differently and certain safety devices were used, 43 percent of those killed in autos might be alive today.

Passenger-car fatalities are shockingly high in contrast to other forms of transportation. A comparison of all forms of transportation reveals that autos are the deadliest vehicles to ride in. Here are the startling figures:

Fatalities per 100,000,000 passenger miles:

Private cars	5.7
Bus	0.13
Railroad	0.05
Domestic airlines	0.14

In actual numbers there were 172 persons killed on domestic flights last year, while ship accidents took 43 lives and 700 people were killed in railroad accidents.

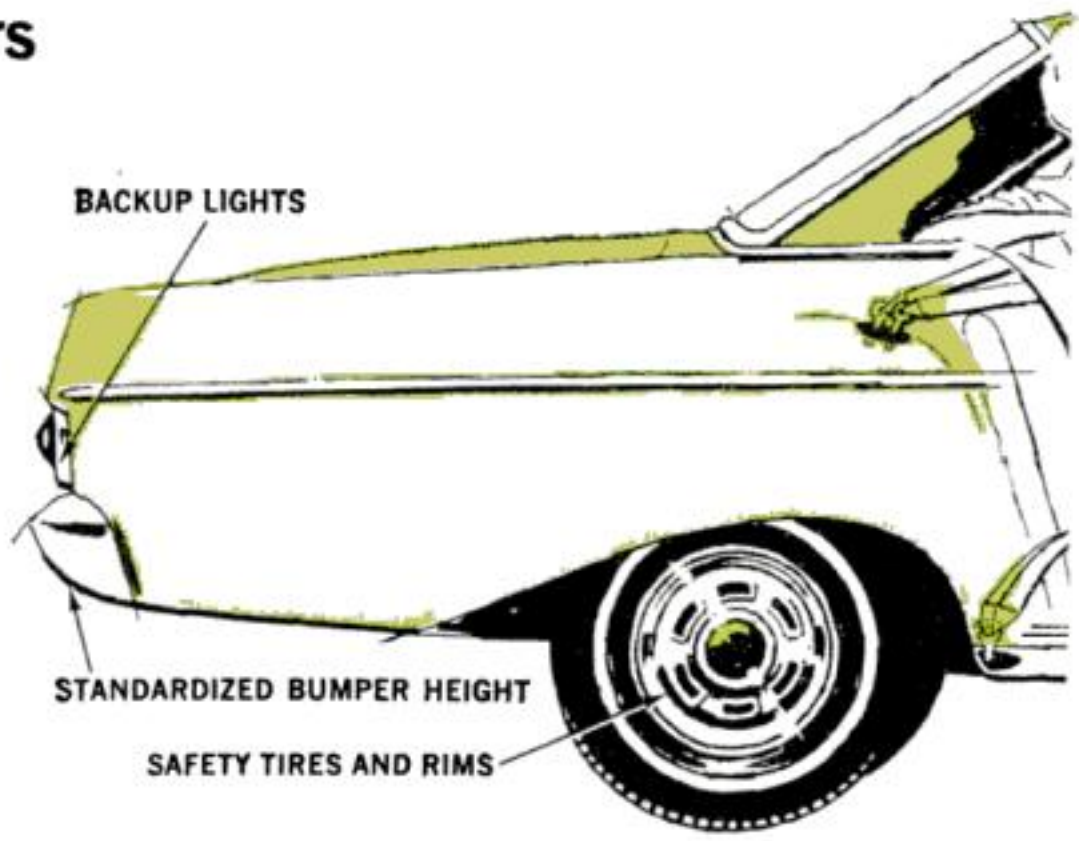
These statistics reveal that our present approach to traffic safety is not doing the job. We also know that our auto-accident rate will climb as more and more drivers pour onto our streets and highways.

I do not think that we have to accept this unnecessary toll of dead and wounded on our roads as inevitable. We must act promptly to make our highways safe.

Why don't we use the same imaginative techniques that we are using to win the race to the moon to eliminate the most deadly features of today's cars?

As Senator Abraham Ribicoff stated recently, it is incomprehensible that we have not been able to develop a steering wheel that does not impale the driver in crashes at 60 miles per hour when we have known about this problem for a decade.

The automobile manufacturers maintain research and testing divisions to make their autos safer. They also contribute to nonprofit research organizations which investigate highway safety. The industry has used some of the findings to produce somewhat



The GSA, purchasing agent for all the cars

safer cars since 1955. But the improvements have not gone nearly far enough.

Although the industry earned about $2.5 billion last year, a Senate subcommittee I am serving on learned, from the Department of Commerce's Highway Safety Board, that the industry spent only about $11,000,000 on basic safety research. During the Senate subcommittee hearings last July, the head of one of the automobile-manufacturing companies could not even tell me how much his firm was spending on safety investigations.

The auto makers have been slow to adopt many of the recommendations arising from the research of safety groups.

Immediate action is vital because our traffic-accident rate has begun to climb again. Twenty years of progress in annually reducing the fatality rate was broken in 1962. This was reflected in both absolute numbers and the number of fatalities per mile traveled, as shown in this chart:

Deaths per 100,000,000 miles:		Total fatalities
1961	5.2	38,091
1962	5.3	40,804
1963	5.5	43,564
1964	5.7	47,700

Our increasing accident rate will not be improved by the additional drivers that will be licensed as our population rapidly climbs

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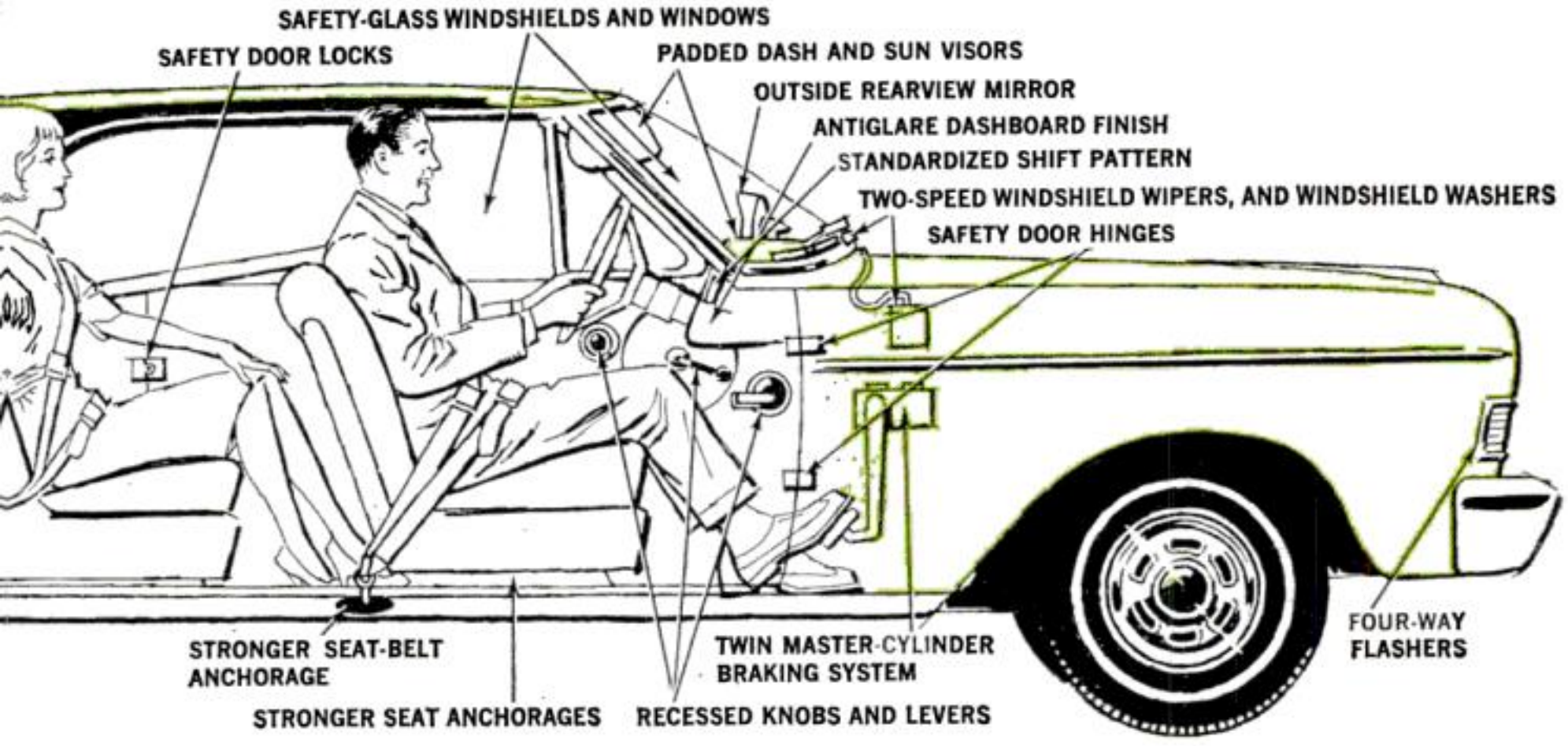

the Federal government buys each year, will require these safety features on 1967 models.

toward 300,000,000. Of the 93,000,000 licensed drivers today, over 30 percent are located in seven states that already have well developed highway systems. There will be many more cars on these roads in the coming years. And this will mean more accidents if we continue on our present path of self-destruction.

A bold new approach to car safety

To reverse this deadly trend, I believe we need a Federal traffic-safety research agency, patterned on Cornell Aeronautical Laboratory's Automobile Crash Injury Research program. This group could institute a massive information system to give us necessary facts on all but minor accidents. Our experience with other federal agencies that conduct research on foods, drugs, air travel, and disease has demonstrated that this is an effective way to solve our most vital problems of health and safety.

A comprehensive traffic-safety program will be expensive. We now spend about $5,500,000 on public auto-safety research. An increase to $150,000,000 a year, as I recommended to the Senate, would give us an effective auto-safety program. Yet even a program that cost twice that amount would be a small price compared to the $8 billion that traffic accidents cost us each year—$40 for every American.

This figure includes measurable property damage and medical and hospital costs. It does not include costs to employers of off-the-job accidents, absenteeism, training, recruiting, and the permanent loss of irreplaceable talent, or the human suffering.

A $150,000,000 program would cost the equivalent of 75 cents per person, or $1.62 per driver each year. I think we can afford this to make our cars and highways safe.

Once established, the federal auto-safety agency could conduct research on how the auto industry can build a car which is less likely to crash and in which driver and passengers can better withstand the damaging impact of collisions; recommend legislation setting standards for production of better cars and safer highways.

Where we could save lives

The most urgent areas in which research might save lives are:

- *Seat belts.* The use of these, harnesses, or other methods of controlling occupant movement during a collision. Belts and harnesses are fairly primitive methods of restraint. A more effective method would not depend on leaving it up to the individual to take positive action such as fastening a belt. One promising approach is a balloon-like device that inflates automatically in a crash and holds the occupant firmly in the seat. But a lot more research is needed to perfect it.
- *Interior padding.* To what extent can the inside surfaces of the passenger com-

CONTINUED

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The U. S. Senate looks into car safety

Sen. Robert F. Kennedy (right foreground) questions General Motors' Chairman of the Board, Frederick G. Donner (white-haired man in center) at hearing before a special Senate subcommittee about the cost of auto-safety items. Ford president Arjay Miller, Roy Abernathy, head of American Motors, and Lynn Townsend, Chrysler's top executive, also appeared before the committee voluntarily. One immediate result of the hearings: a bill sponsored by subcommittee chairman, Sen. Abraham Ribicoff and Sen. Kennedy, which would set up a $150,000,000 National Highway Traffic Safety Center as a division of the Department of Commerce.

partment be made safe for high-force impact?

- *Door locks.* How to keep doors closed and keep people from being thrown out of cars on impact.
- *Bodies and chassis.* We need to know more about how energy from an impact can be absorbed in external structures and still keep the passenger compartment intact in a crash.
- *Seats.* How can they provide better support for the driver and how can they be kept from tearing loose from their anchorages, or jackknifing?
- *Brakes.* We need brake systems that: 1) stop a car traveling at high speeds more quickly, reliably and without swerving; 2) do not fail totally when one component of the system fails.
- *Visibility.* How can we give the driver a better view of the road and traffic ahead of him and behind him? Especially acute is the problem of drivers being blinded by oncoming headlights at night.

A safer car is only part of the answer

Besides conducting its own research into these areas, the new agency could effectively monitor the private research and sponsor research projects that are best performed by private institutions.

But building a safer car is only part of the answer to the overall problem. Additional research is needed into improving roads, median dividers, road signs, and above all, human driving factors.

We find now that very little is actually known about what automobile models are dangerous, or the location of dangerous places on our highways and streets so they can be promptly corrected. A relatively simple information system could tell us if a particular automobile model is dangerous. We could borrow from aviation and "ground" that model until the problem is solved.

Right now safety experts believe that mechanical failure, such as a broken tie rod, bad brakes, or tire failure, ranks low as a cause of accidents. The largest single factor, experts believe, is driver error—including the 7.4 percent of traffic accidents caused by drinking. But we really do not know whether it is the road, the driver, or the vehicle that causes the accident. We need this information if we are to make our highways safe.

The federal government can help to clarify the great confusion in traffic-safety planning, regulation, and enforcement. Only 18 states require annual safety inspections and standards differ widely. In some areas inspections are performed in private garages, and in others by public officials.

Some states don't require automatic turn signals that may be mandatory in the next state. Other states prohibit four-way blinker systems for tail and headlights, while some states encourage motorists to use them.

All 50 states have their own licensing requirements for vehicles and operators, and over 8,000 local and state police forces enforce these regulations. Standards for planning and constructing highways and streets vary widely. All this results in confusion.

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Photo from Automotive Business

The federal government has helped to standardize some elements which may lead to greater highway safety. The Bureau of Public Roads, which oversees the construction of the Federal Highway System, has contributed greatly in cutting the death toll on highways built under this system. The bureau's recommendations on grading, banking of lanes, and other safety standards have helped hold down the fatality rate for these highways to 2.8 persons for every 100,000,000 miles traveled compared with the 5.7 for all roads combined.

The General Services Administration, which is the purchasing agent for the 60,000 cars the U. S. buys each year, has announced it will require 17 safety features on its 1967 models (drawing, p. 65). As a result of these requirements, most of the major automobile manufacturers will incorporate many of these features in the 1966 models.

There are other precedents for federal action to promote car safety. The Division of Accident Prevention of the Public Health Service, the Commerce Department's Office of Highway Safety, and the Interstate Commerce Commission all play a role in highway safety. But the total annual expenditures of these agencies aren't quite $5,500,000.

I think that our high fatality and accident rate can be lowered if our car manufacturers place greater emphasis on car safety. Even a small portion of the industry's $2.5 billion profits, spent on auto safety, could make a major difference.

There is also much that research has revealed that hasn't been put into use to cut fatal auto accidents. The auto industry could effectively implement many of these safety features now.

Is safety really more expensive?

What appears to be stopping them is the conviction held by each company that they would be at a competitive disadvantage if they increased their costs with safety features that the general public has demonstrated an unwillingness to pay extra for. Obviously, the only way out of this dilemma is to require proven safety features so that they are removed from the area of price competition. This would spike the principal auto industry excuse that "safety doesn't sell." We may also find that safety doesn't cost more—on a mass scale.

Disk brakes, standard equipment on some European economy car models, are used only on a few higher-priced American cars (they're extra-cost options on some lower-priced cars). These brakes offer more stability in stopping than the standard drum brakes. Many American cars now lose directional control under heavy braking.

More stability and better control of the car at high speeds can be achieved with present hardware and technical know-how. One big factor is the lack of adequate shock-absorber control on American production cars. On moderately rough roads they bounce around dangerously and sway enough in high-speed maneuvers to risk loss of control by the average driver. Even the modest amount of control exercised by the shocks on new cars is soon diminished seriously because they wear out too

[Continued on page 210]

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Sony's Videocorder and plug-in camera make a complete home TV system. Cost: $1,350.

Personal-use report:

Home Videocorder

SURE it works—but is it really practical for home use? That's what I wanted to know when I saw a prototype of the Sony home TV tape recorder last summer [PS Aug '65, p. 106]. To find out, I recently lived with a first-run production model for several weeks:

- Despite its imposing appearance the Videocorder is as easy to operate as a conventional hi-fi audio-tape machine. The only additional control is a video-level adjustment.
- At a touch of a button the unit will record a TV broadcast off-the-air, and then play it back as often as you like, through its own nine-inch TV set. One reel of tape holds a full hour of TV.
- Connect an accessory TV camera, and the Videocorder becomes an instant home-movie maker—the camera photographs the action and a plug-in mike captures the accompanying sound simultaneously.

How it works. A video signal contains a wide range of high- and low-frequency components that occupy a band of frequencies over two-megacycles wide. The Videocorder must capture most of these, or picture playback definition will be poor. The basic requirement of a wide-band recorder is a very high relative speed between the tape and recording head.

Early home TV recorders used a direct approach: A hopped-up audio-style transport-propelled tape past a stationary recording head at uneconomical high speeds—often exceeding 120 inches per second.

The Videocorder's rotating head spins at 1,800 r.p.m. inside a slotted drum; specially coated ½-inch-wide magnetic tape (an hour-long reel costs $40) snakes around the drum at a slow 7½ inches per second. The spinning head records the video signal on adjacent diagonal stripes along the tape at a

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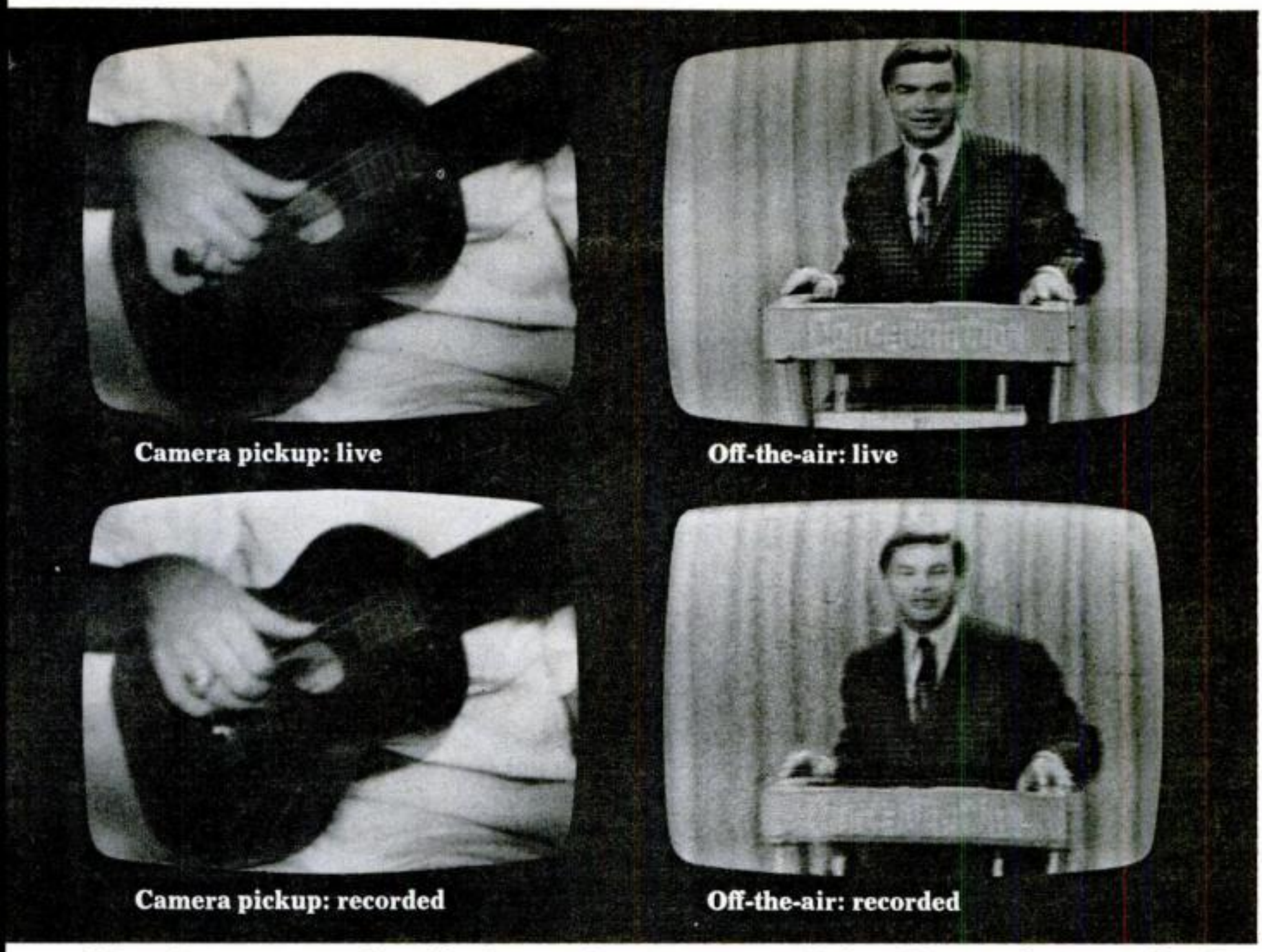

Live picture versus played-back recording: Can you tell the difference between them?

Works Like a Real TV Studio

relative tape/head speed of over 200 i.p.s.

Playback picture quality is good—far better than other home TV recorders. There are occasional bursts of picture jitter and tearing, and random signal "dropouts" that show up as black streaks on the TV screen.

Definition is noticeably less than in an off-the-air picture, but not enough to be annoying. To my eye, the picture was always viewable. Sony, NYC.—*R. Benrey.*

The rotating video head provides wide recording bandwidth (over 2 megacycles) necessary to capture a complicated video signal, yet keeps tape speed at 7½ inches per second.

The accessory TV camera costs $350, complete with tripod and carrying case. The snap-up viewfinder is mostly for show—it's easier to use the recorder's TV set as a "monitor."

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MAN AMPLIFIERS:

Superman suit is modeled by the author at Cornell Aeronautical Lab, Buffalo, N.Y. Joints will be powered to multiply the wearer's strength as structure follows his movements.

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Machines That Let You Carry a Ton

Strap on the "exoskeleton" and your strength is multiplied many times over—you'll be able to handle a ton with all the flexibility of human muscle power

By **WALLACE CLOUD**/*PS Science Editor*

When they strapped me into the superman suit, I felt like Frankenstein's monster getting up off the operating table.

I clonked around the room like a gorilla, with this 35-pound jointed "exoskeleton" hanging onto me.

"Why are you bent over like that?" said Neil Mizen, the project engineer at Cornell Aeronautical Laboratory.

I straightened up and discovered that I could move freely, even though the exoskeleton didn't have quite as many joints as I did. It wasn't up to some of the intricacies of the frug, but it followed me pretty closely.

The next step will be to put hydraulic motors at all the joints, and then it really will be a superman suit. Wearing it, any normal person will be able to heft 1,000 pounds—with each hand. You'll be able to carry a ton like a sack of groceries.

You'll have an 80-pound power pack on your back—a 20-horsepower gasoline engine plus fuel tank. But you won't be carrying it. The powered exoskeleton will be,

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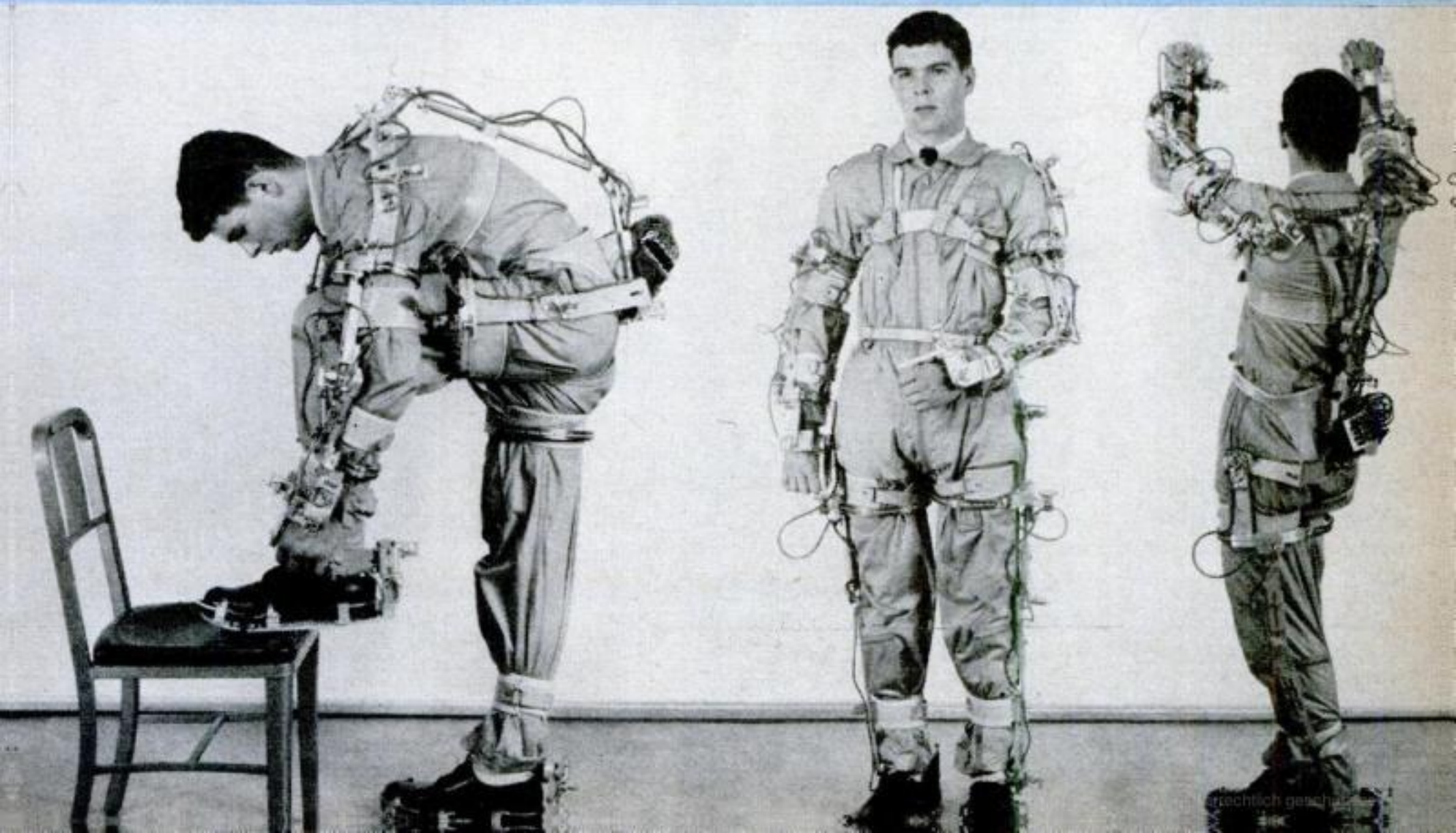
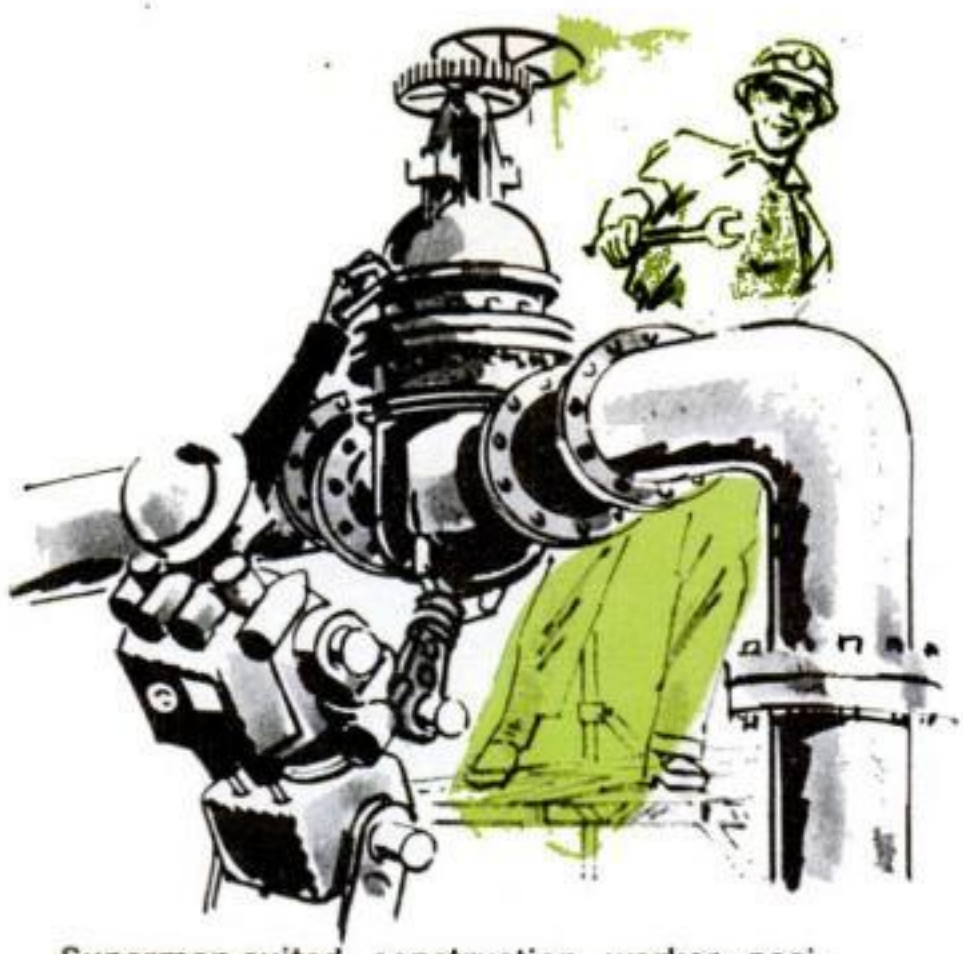
Flexibility of exoskeleton, wired to record motion, is shown by technician Ronald Patterson.



Tricky problems remain to be solved, but the uses of man amplifiers—

First uses of the exoskeleton are expected to be military. Here, a GI in a superman suit unloads munitions at a jungle helicopter landing field.



Superman-suited construction worker positions a heavy valve on site of a chemical plant—one of many civilian uses foreseen.

and it will also be supporting its own weight of about 400 pounds.

What a nutty idea, I thought when I first heard of it. But it turns out this is no joke. It's being developed for the Office of Naval Research.

The Navy wants the superman suit to help sailors manhandle torpedoes, bombs, and machinery in the cramped quarters aboard ship and in submarines. The exoskeleton could take the place of any number of hoists, overhead cranes, and other special-purpose weight-lifting equipment.

The Air Force and the Army are also interested. Exoskeletons would be useful for unloading and handling cargo and weapons in rugged terrain such as the jungles and rice paddies of Vietnam, and for construction work where a lot of specialized machinery is not available.

Multiplying muscle power. Cornell's exoskeleton is one of several "man-amplifier" projects underway in the U.S. Although there are differences, the basic idea is to put a man inside a machine that will duplicate his movements, but with greatly amplified strength and endurance.

One of these is the well-known "pedipulator," or walking machine, which GE has been developing for several years. This 18-foot-tall monster would walk on jointed legs, duplicating the movements of a man standing inside a cab at the "hips" of the machine. GE is working on the legs now, planning to add powerful arms.

A number of laboratories are doing research on controlling such machinery with "myoelectric" signals—electric currents generated by the muscles. The signals can be detected by means of electrodes taped to the skin. This research is aimed largely at developing better artificial limbs for amputees, but myoelectric signals could provide fast, sensitive control of man amplifiers.

When production models of man amplifiers are available, it's unlikely that they will be limited to military use. In factories and construction work, man amplifiers, perhaps costing only a few thousand dollars, will be able to do more things than present materials-handling equipment. They will be able to operate without special installation or site preparation, and will also make it possible to move and manipulate heavy objects with delicacy and precision.

Some tricky problems remain to be solved. At Cornell, project engineer Mizen explained, the approach was to build an unpowered exoskeleton that would cling to a man, to see what kind of strength-increasing structure could be built, and how many joints it would need and how they would have to move. The one I tried on was the result.

It was built to the measurements of

[Continued on page 204]

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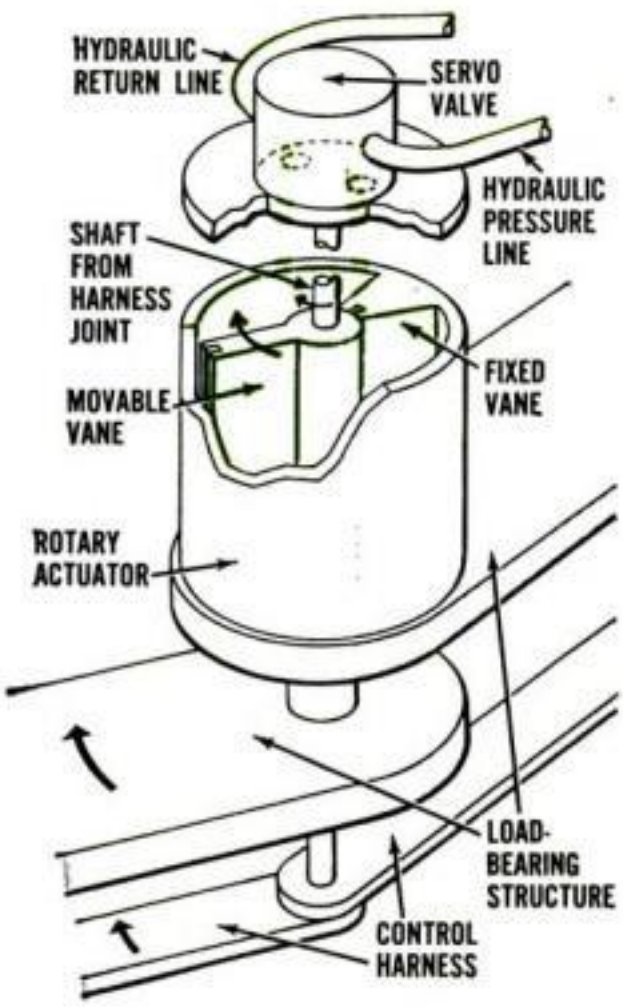
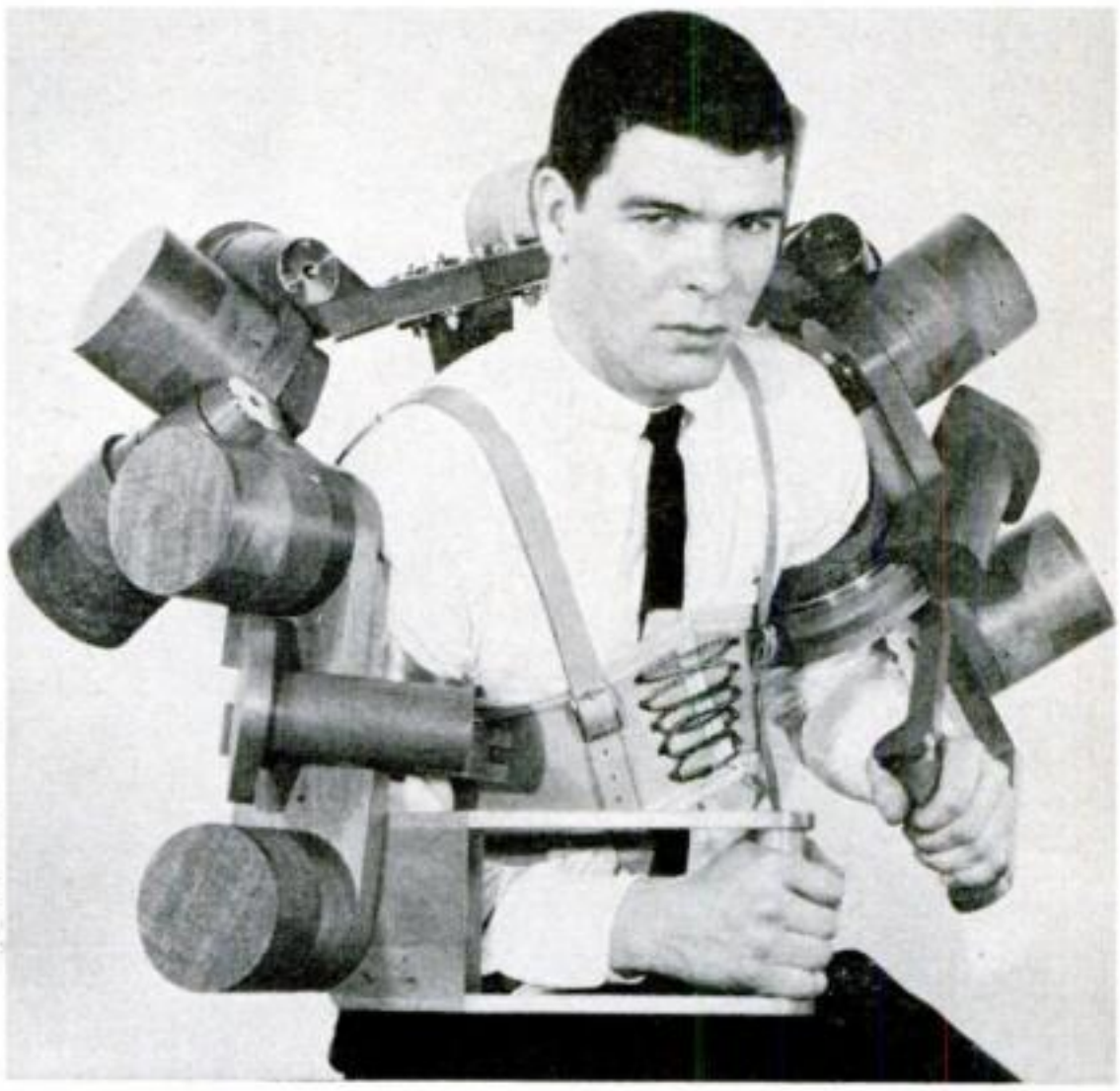
military and civilian—are limited only by your imagination

Exoskeleton can be made bigger or smaller than the man in the control harness. Here, a giant version replaces a derailed ore car at a mining site.

A miniature version, exposed to radioactivity, works to free jammed control rod of a nuclear reactor as operator watches on a TV monitor.

Next phase of development: applying power to the joints





Acid test of Cornell's exoskeleton design is whether power applied to the joints can be controlled precisely by the wearer. Mock-up shows sizes and locations of the hydraulic motors or actuators that will power the exoskeleton's arms and shoulders. This load-bearing structure will be linked to a harness like the unpowered exoskeleton shown on preceding pages. How each harness joint controls the corresponding joint of the structure is depicted in the diagram, an exploded view of the hydraulic actuator and servo valve attached to the joint. Movement of the harness joint is transmitted by its shaft to the servo valve atop the actuator. The valve regulates the pressure of hydraulic fluid on each side of the movable vane in the actuator. Movement of the vane is conveyed by its shaft to the structural member, positioning the structure joint so it corresponds to the position of the harness joint. Some pressure is fed back through the valve, so the wearer knows the position of the structure.

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Buyer's Guide to the Big

Though you may not see the differences, all three are improved now. Weaknesses? PS's free-swinging auto editor pinpoints some you'd never learn about from the salesman

By Jan P. Norbye, Automotive Editor

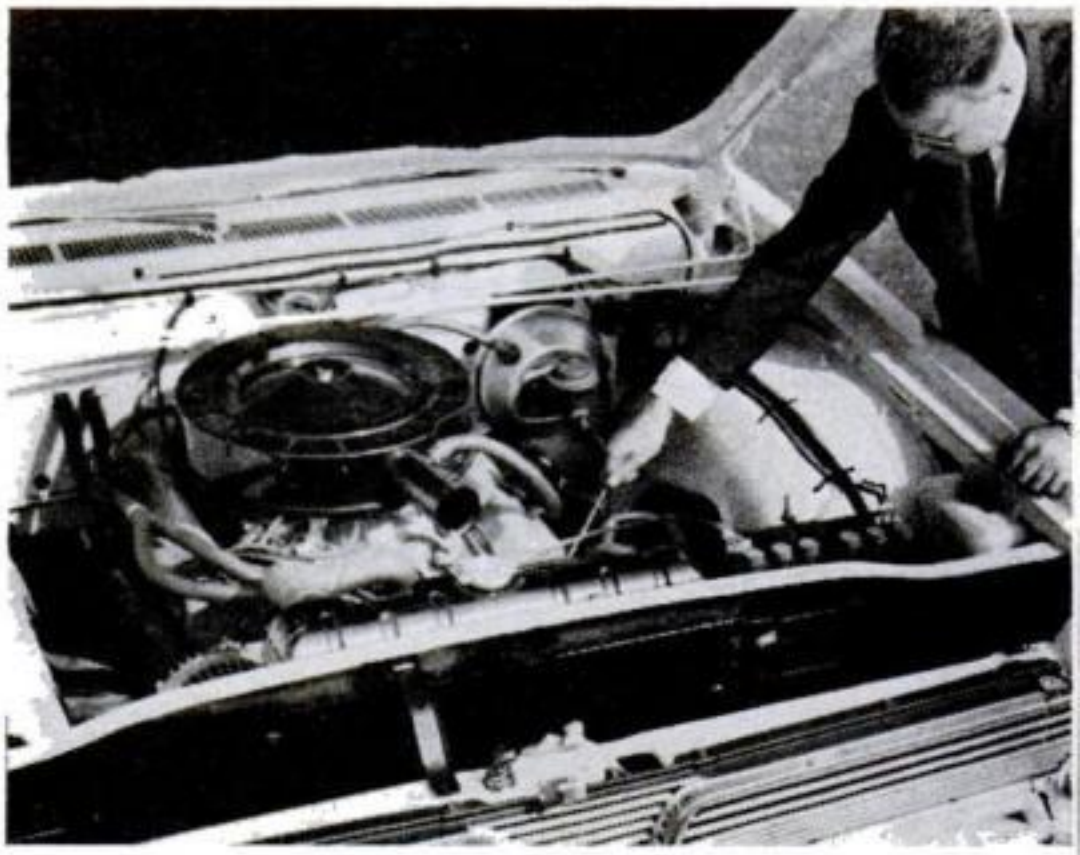
Exclusive Photos by Bill Morris

ALL changes are improvements, if you believe the salesmen. Chances are you don't. Some of the changes on the 1966 models are genuine improvements: others are not. But I found that the changes that were most needed weren't made.

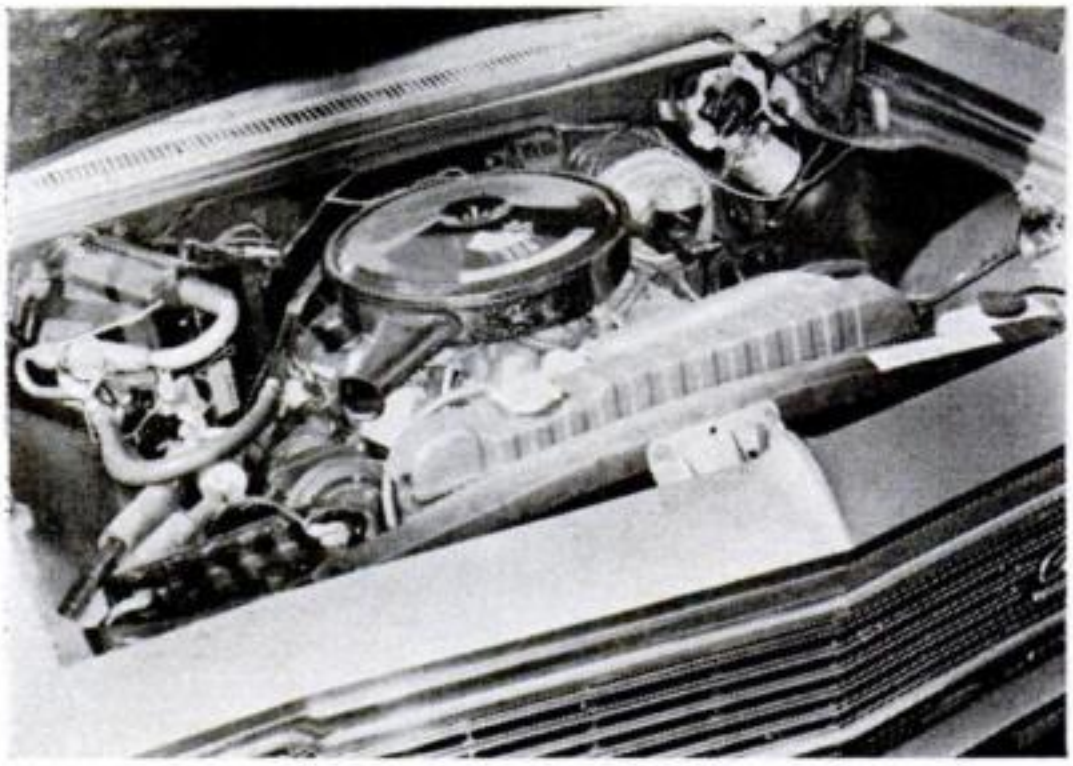
My criticisms and pet peeves notwithstanding, the new Plymouth, Chevrolet, and Ford are real bargains. They give you more room and comfort, power and performance, quietness and safety, durability and resale value than any other car you can get for the same money.

They are alike in these respects, but there are also some surprising differences. Among them:

Engines. Ford's 390-cu.-in. V-8 is derived from its first overhead-valve V-8 of 1954, and today it can only be described as an old heavyweight—tough and reliable but with mediocre fuel economy and low specific output. Plymouth's short-stroke 383-cu.-in. V-8 came out in 1958 as a development of the wedge-head engine which replaced the hemihead in production models in the mid-fifties—another heavyweight. But Chevrolet's 396 [PS, May] is a new engine—with excellent breathing characteristics, a wide torque range, relatively light weight, and outstanding performance. It must be one of the most efficient U.S.-built engines ever mass-produced. Chevrolet has a clear lead in the engine department.

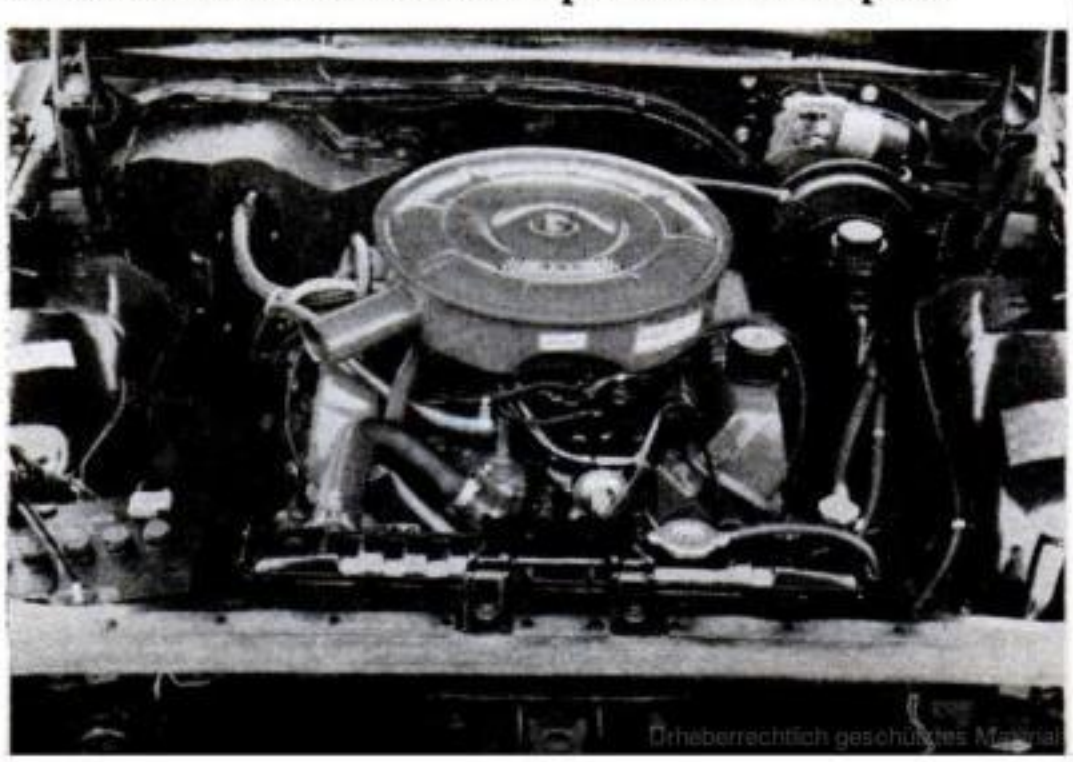


PLYMOUTH Fury matches Chevrolet on power,



CHEVROLET Impala is lower, wider, and longer

FORD Galaxie 500 has 10 hp. less than Impala



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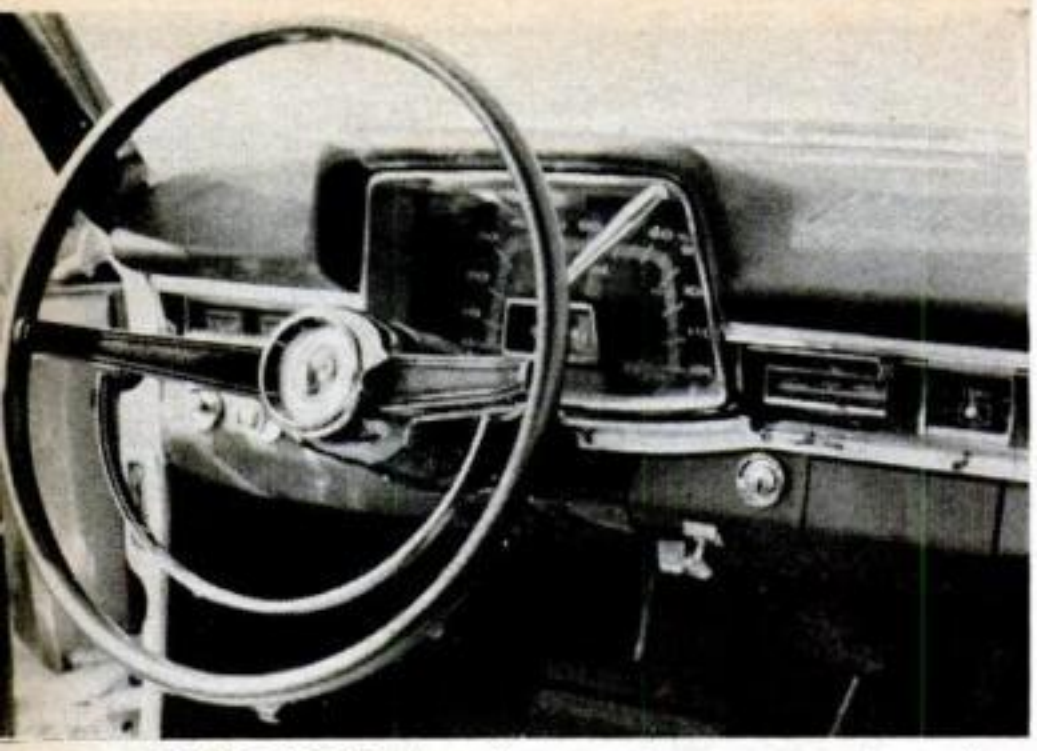
Three: PLYMOUTH·CHEVROLET·FORD

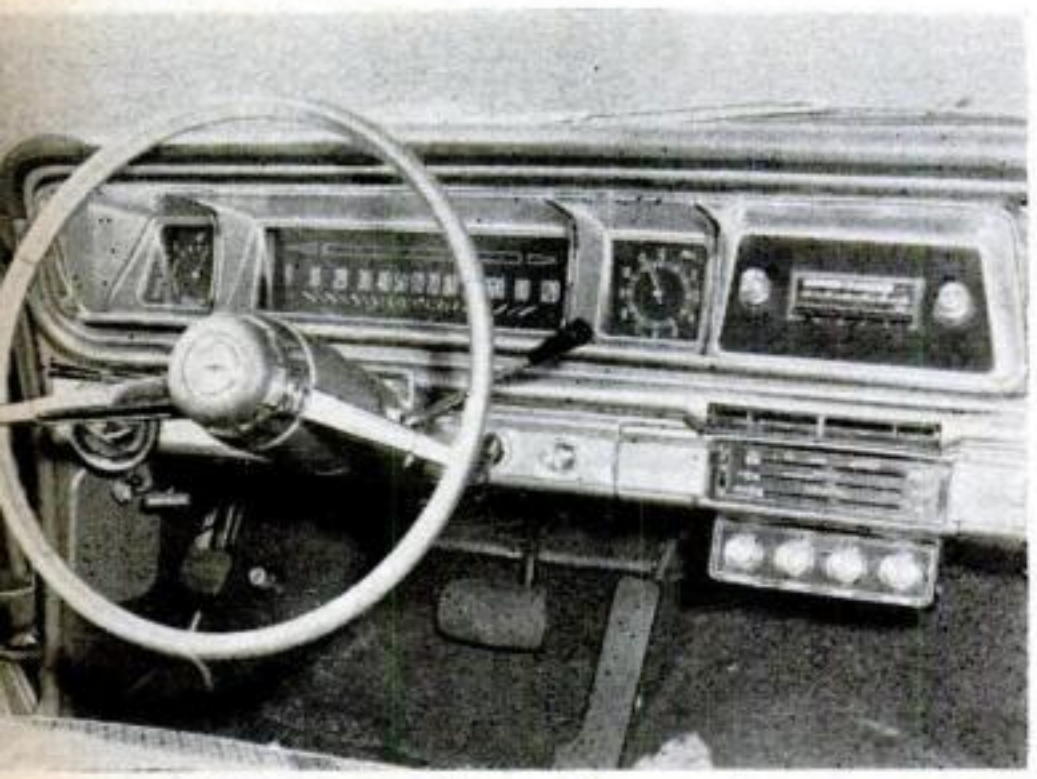
but is heavier and has more frontal area. Ride comfort is improved but the handling is not.

than its rivals. It has superior handling precision and a soft ride, but no disk-brake option.

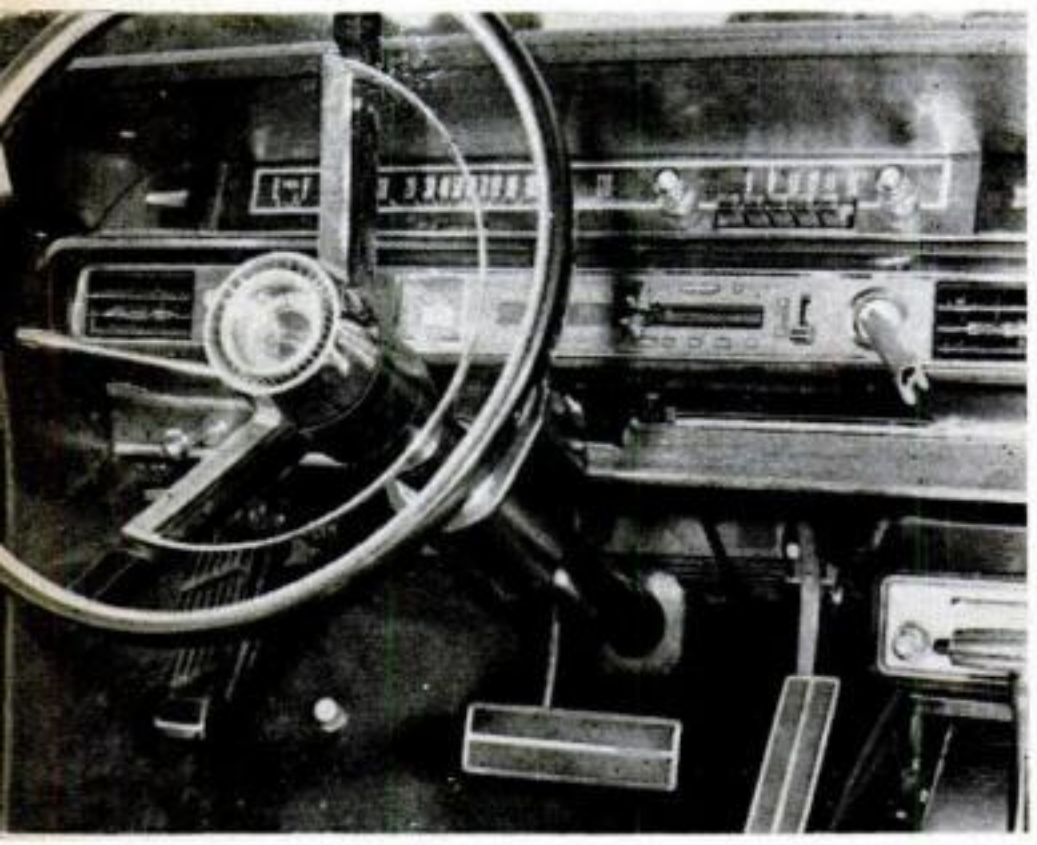
and Fury but is still a fast car. On hard cornering, rear wheels retain road grip, front plows.



PLYMOUTH has better instrumentation than Ford, Chevy (ammeter and temperature gauge in place of lights; easier-to-read speedometer).



CHEVROLET offers a better driving position, with steering wheel set low in driver's lap. Impala's instrumentation is deplorably scant.



FORD GALAXIE has a hooded instrument panel to prevent windshield reflections. Accelerator pedal is suspended and gives accurate control.

Transmissions. Last year we had a big beef with Chevrolet for their continued use of the obsolete two-speed Powerglide. Unfortunately, Powerglide is still the standard transmission on all sixes and the small V-8 (283 cu. in.). But the new 396 engine offers a choice—it's available with Turbo-HydraMatic, which I think is probably the most advanced and universally acceptable automatic transmission you're likely to find.

TorqueFlite in the Plymouth probably has lower power losses, but lacks such refinements as a variable-pitch stator member, automatic adjustment for altitude, and water cooling. Ford's Cruise-O-Matic has no particular weakness, but is overshadowed by both its rivals. My transmission choice? It's a toss-up between the Turbo-Hydra-Matic and the TorqueFlite.

Brakes. Drum brakes are standard on all, and they are entirely adequate for everyday driving in most areas. Under hard braking, however, they all have a stability problem, pulling left or right, needing a firm—and prepared—hand at the wheel.

Ford and Plymouth offer optional disk brakes on the front wheels, which effectively eliminate the stability problem. The disks also reduce fade and offer at least equal lining life. Plymouth's disks are made by Budd; Ford uses the Kelsey-Hayes system (adapted from the Thunderbird). Which is best? They are both so far superior to drum brakes that the question can only be answered after an extended test. I'd give Chevy a demerit for not having a disk-brake option (although their optional heavy-duty drum brakes are among the best in the business).

Ride and handling. Even with stock suspension, the cars are well balanced, with good directional stability and firm understeer. But in high-speed driving you notice little differences that soon become mighty important:

- Plymouth has a strong roll oversteer action on hard cornering which makes it necessary to countersteer with the wheel. The problem of rear-wheel steering when the body leans over has been accentuated by the change to softer rear springs for improved ride comfort.
- Ford's front suspension system will not let the car stay on its intended line on a fast turn if the road is bumpy. The steering angles change too much on spring deflec-

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tion; incessant steering corrections are needed to keep the car on its line.

● Chevrolet has a ride problem on certain washboard surfaces, causing wheel hop and sideways movement of the rear axle. This is unpleasant for the passengers and calls for steering corrections.

My preference for ride and handling is the Chevrolet. It has greater handling precision under all conditions, and a faultless boulevard ride on most surfaces. Plymouth has the best rough-road ride, and is faster than the Chevy on a twisting country road. Ford probably has the best rear suspension, with a lowered track-bar mounting that gives reduced pitch and higher stability, but I could not fully appreciate it because of my irritation over the front end's behavior.

Body and frame. Plymouth continues the excellent integral construction that was adopted in 1959. It consists of a separate fore structure bolted to the unit structure that starts at the cowl and ends behind the passenger compartment. It offers remarkable twist rigidity, absorbs greater bending loads, and is less prone to shake and beaming (that's what a small bridge does under a heavy load) than structures with separate bodies and frames. Over the years, Plymouth has done a great deal of development work on the traditional troubles with unit construction (isolation of drive-train vibrations and road noise from the body structure) and the 1966 Fury II is probably just as quiet—overall—as the Impala and the Galaxie.

Chevrolet seems to be following Ford's lead in body-mounting theories. Both went to torque-box perimeter frames on the 1965 models (Ford from a channel-section frame with cross bracing; Chevy from a true cruciform frame), but Ford's solution seemed braver than Chevrolet's—and turned out to give a quieter car. Now Chevrolet has beefed up the frame and revised the body mounting points. My "structure" preference is Plymouth—I like the solid feeling of its practically shakeproof unit-body.

Options. No matter how many options we detailed in last month's PS, the auto makers have still left something out. The regular Chevrolet, Ford, and Plymouth can be decked out with as much luxury as a Cadillac, Lincoln, or Imperial. There are optional power teams that would put them in the rocket-booster class, and there are special suspension systems that make the cars corner as flat as an Indy roadster. But

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PLYMOUTH has well-dimensioned rear seat with more head room and hip room than Ford and Chevrolet. Rear seat belts are standard in all.

CHEVROLET has a lower seat height both front and rear and still offers more leg room. GM styling seems to have stolen some hip room, however.

FORD has the same overall width as Plymouth, but less hip room. The backrest is pleasantly contoured and gives some sideways support.

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there are also some things you cannot get at any price:

- A power-steering system that gives adequate road feel and positive self-centering action.
- A power brake that offers adequate pedal feel to warn against imminent locking.

I like to get an indication of the forces acting on the car through the controls, and I am not satisfied with the "dead" feel of either the Saginaw power steering used by Chevrolet and Plymouth or Ford's own system as fitted to the Galaxie. The engineering problems of making power steering with proportional assist were licked long ago, but the industry seems to have forgotten. When reminded, they talk lamely about some ladies' complaints of hard steering.

You will probably agree with me that steering response should be instantaneous. There is little lost motion, but the overall steering ratios on these cars are still pretty high. Plymouth has even made a step backward by going from an 18.8:1 to a 19.4:1 ratio (which means 3.8 turns of the wheel from lock to lock, instead of 3.5).

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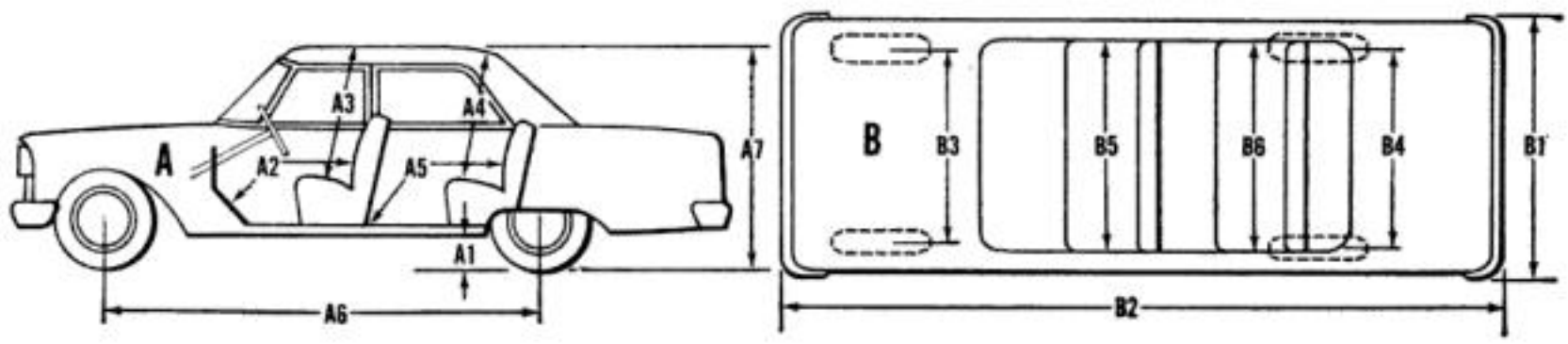

	CHEVROLET Impala	FORD Galaxie 500	PLYMOUTH Fury II
DIMENSIONS (inches)			
A1 Ground clearance	5.3	6.0	5.8
A2 Front leg room	43.0	41.8	45.0
A3 Front head room	39.0	38.8	39.0
A4 Rear head room	38.0	37.7	38.2
A5 Rear leg room	39.5	37.8	38.0
A6 Wheelbase	119.0	119.0	119.0
A7 Overall height	55.5	55.6	57.0
B1 Overall width	79.5	78.7	78.7
B2 Overall length	213.0	210.0	209.8
B3 Front track	62.5	62.0	62.0
B4 Rear track	62.4	62.0	60.7
B5 Front-seat width	62.3	62.6	63.5
B6 Rear-seat width	61.4	62.7	63.5
SPECIFICATIONS			
Engine type	OHV V-8	OHV V-8	OHV V-8
Bore & Stroke	4.09 x 3.76	4.05 x 3.78	4.25 x 3.38
Displacement	396 cu. in.	390 cu. in.	383 cu. in.
Compression ratio	10.25:1	10.5:1	10.0:1
Carburetion	Single 4-bbl.	Single 4-bbl.	Single 4-bbl.
Power @ r.p.m.	325 @ 4,800	315 @ 4,600	325 @ 4,800
Torque @ r.p.m.	410 @ 3,200	427 @ 2,800	425 @ 2,800
Transmission	Turbo-HydraMatic 3-speed planetary & torque converter	Cruise-O-Matic 3-speed planetary & torque converter	TorqueFlite 3-speed planetary & torque converter
Axle ratio	2.73:1	3.00:1	3.23:1
Tire size	7.75x14	[illegible]15	7.75x14
Steering ratio	24.0:1	20.7:1	19.4:1
Turns (lock to lock)	4.125	4.1	3.8
Turning radius	20.4 ft.	20.5 ft.	21.3 ft.
Brake-swept area	328 sq. in.	346.5 sq. in.	328.3 sq. in.
Curb weight	3,985 lb.	4,040 lb.	4,070 lb.
PERFORMANCE			
0-60 m.p.h.	8.9 sec.	9.2 sec.	9.3 sec.
0-80 m.p.h.	15.1	18.0	17.2
40-60 m.p.h.	3.7	4.0	4.2
50-70 m.p.h.	4.0	6.1	5.9
SS ¼-mile	17.0	17.7	17.3

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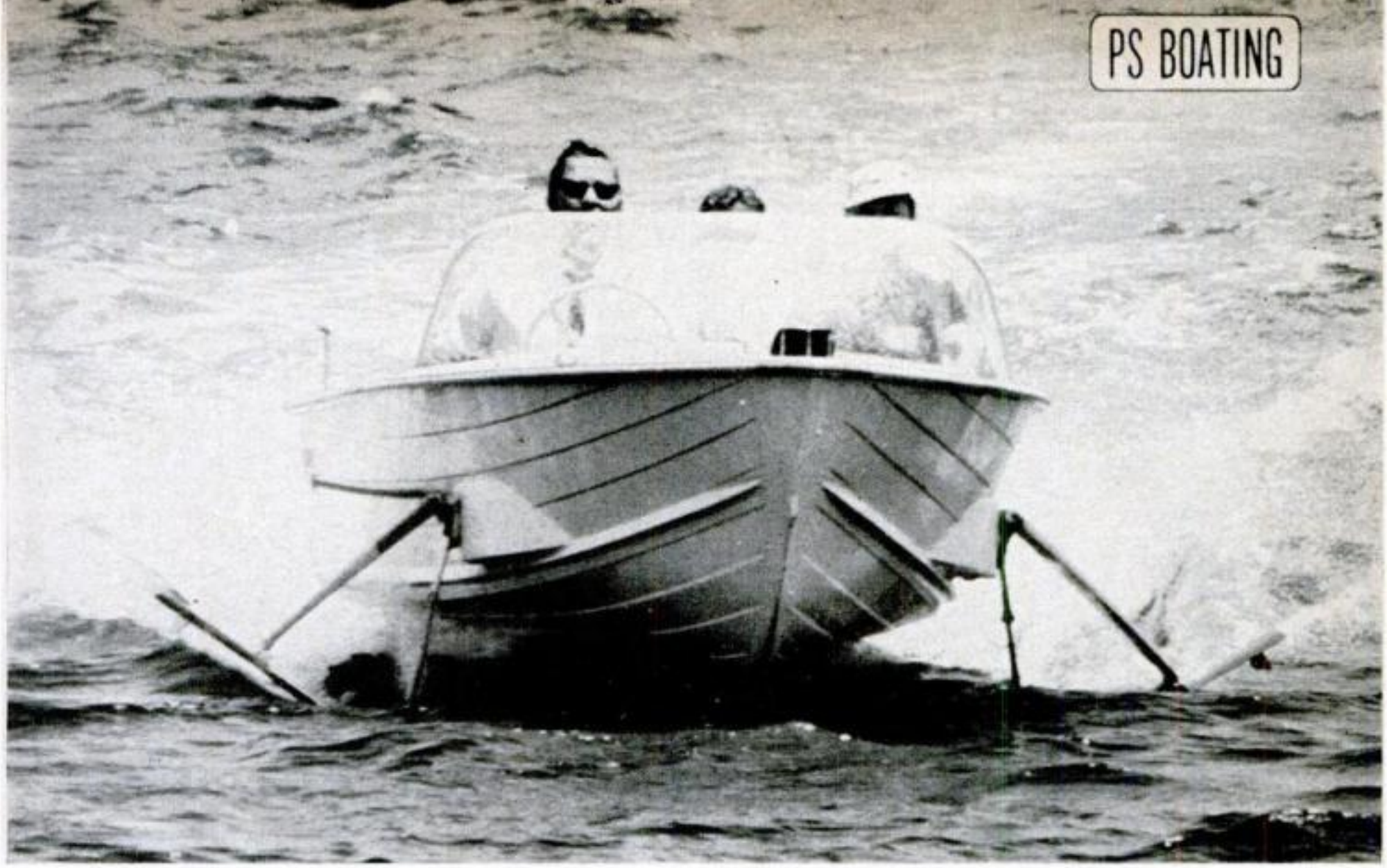

Foils give you a wonderful feeling of "flying above the weather" in choppy water.

I "Flew" an Outboard Hydrofoil

By Jim Martenhoff

New add-on hydrofoils lend wings to any powerboat from 14 to 20 feet long

ONE moment the 15-footer was literally up in the air, flying along a few inches above the water's surface. Then, after a light thump and an almost imperceptible shock to the aluminum hull, we were down in the water again. A shower of spray rose from the bow, and I cut the throttle.

I had been "flying" a new hydrofoil—outboard powered—and we had struck a submerged object. It turned out to be a piece of wood, jammed in the starboard foil. It was easily removed, and we were flying over the waves again in less time than it takes to tell about it.

The stock outboard I was test-driving was fitted with new accessory hydrofoil wings designed to fit any powerboat from 14 to 20 feet in length. Developed by an American-owned Swiss corporation, the Supramar foils weigh only 140 pounds: 60 pounds for each of the "wings" mounted forward; 20 pounds for the small unit astern. They were installed on a 15-foot Starcraft powered by a 40-horsepower Johnson.

The units forward extend down into the water on each side of the hull and act much like airplane wings. When the boat is moving, the foils lift the hull completely clear of the water. Free from the many-fingered

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"When I hit the throttle, I was startled at

grasp of water friction, the boat is lively, agile, and fast.

When I first took the wheel and hit the throttle, I was startled at the speed with which the foil-equipped boat responded. She literally leaped into the air, and we were foilborne within seconds.

In rough water. It was windy, and whitecaps roiled the water's surface. If we had been racing over the choppy sea in the same boat without foils, her conventional design would have caused hard pounding and sore spines. But when we rose on our underwater wings to fly above the chop, the ride was smooth. No pounding, no excessive vertical motion; just the wind in your face, an occasional thimbleful of salt spray, and an exhilarating sense of speed.

The Supramar foils for small powerboats were made of ordinary carbon steel in the test version. A switch to stainless is planned. At present, the stern unit is fastened to the hull, an obvious disadvantage. Launching from a trailer and shoal-draft operation are impossible. When finally marketed, sometime in 1966, Supramar engineers hope to have a tail foil that will attach to the outboard or stern drive's lower unit—making it retractable.

The two side foils forward are retractable now. In the test version they lift mechanically, lock up out of the water. A hydraulic system will be available on the marketed foils, allowing full retractability of all units at the touch of a button.

The configuration is what foil engineers term conventional: a foil forward on each side, one at rear. It is more stable than the "canard" types, which usually display single foils forward and aft.

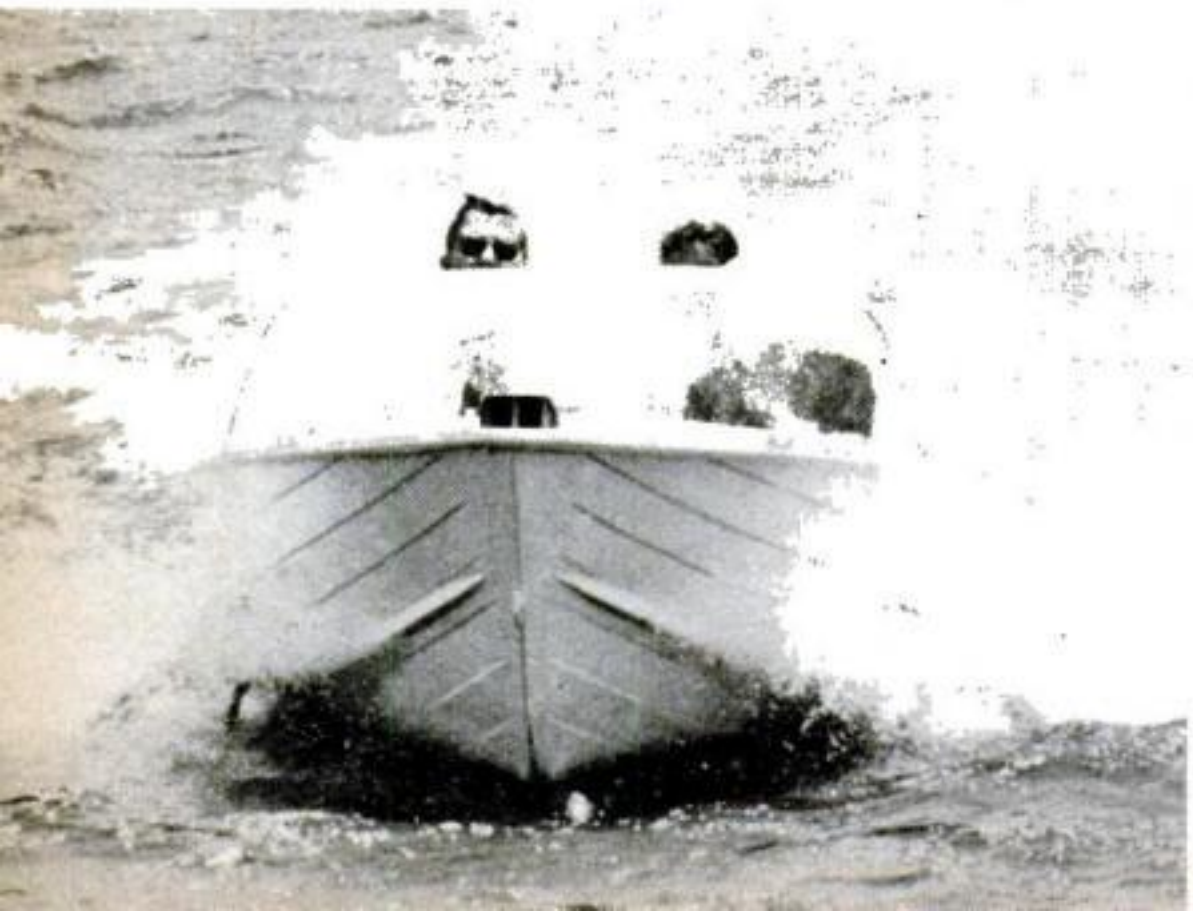
The foils are subcavitating, closely resembling an ordinary aircraft wing in cross section. When moving through the water, they produce lift in much the same way: through upward pressure on the bottom surface of the foil, and through a lessened pressure and lifting effect on the upper plane. Very little area is needed to obtain the lift, because water is some 800 times denser than air. Thus the "wings" can be relatively small.

The cavitation problem. Subcavitating foils are useful to a limit of about 50 or 60 knots—nautical miles per hour. At higher speeds, cavitation, or a frothy mixture of bubbly air and water, can erode the foils' surfaces as it destroys the lifting effect. Supercavitating foils are thinner, designed like a jet fighter's wings, and can cross this cavitation barrier with no loss of lift or erosion damage. But they aren't necessary on Supramar-equipped craft, which will "fly" at slower speeds.

Inboard-mounted controls permit adjusting the angle of attack on the Supramar foils up to three degrees to compensate for changing loads. Foils are mounted with shear pins; striking an object heavy enough to snap a foil just shears the protective pin. Replacement takes only moments.

Hitting an obstruction in the water is always the first worry of hydrofoil skippers. But it turns out to be no sweat. When we struck a fair-size piece of wood, it was too small to shear the pin, yet it was large enough to knock us down out of the air.

Foil-equipped Starcraft rises off water in moments. Just hit the throttle and you're on



the speed with which the boat responded"

Our "crash landing" was soft—hardly noticeable, in fact. We just mushed down into the chop and took a hatful of spray over the bows before I could cut the throttle. So hitting any object—large or small—is no problem in a hydrofoil.

Response is instantaneous. In numerous tests of her ability to get up and go, the foil-equipped Starcraft jumped up on her wings at every thrust of the throttle. The boat, gliding above the water on her foils, had none of the motion a small craft usually acquires in a seaway or bad chop. No swaying or roll; no pitch or pound. In fact, it was a rather odd feeling to make a fairly hard-over turn and ride perfectly level. No bank, no tripping or skidding, and virtually no sign you were turning except the seat-of-the-pants feeling and the moving shoreline.

The Supramar foil boat is speedy. Engineers say you can gain up to 40 percent in speed from the same amount of power when you equip a boat with foils. Or, to put it another way, you can "fly" with less power.

On the debit side, it must be admitted the ride wasn't any smoother in a chop than that with a well-designed deep-vee or cathedral hull of comparable dimensions.

The turning circle is somewhat larger. You can't put that wheel hard over and spin around in a tight turn. Also, even with the foils retracted, it calls for more than ordinary care in docking and maneuvering situations. You can't really hurt the foils; they're tough. But until you master them, you have to be very careful not to go banging and bumping into other boats and into the pierhead.

Foils also need a reasonably speedy craft in order to fly. In the case of the test boat illustrated here, it became foilborne at about 18 miles per hour. sped along—hull out of the water—at top speeds well above 30. Performance, of course, depends largely on the boat and its motor.

Hydrofoils for small boats are not entirely new. I saw a foil-equipped boat run in South Florida's Gold Coast Marathon a few years ago. Marketing plans have been developed before this, but none ever got out of the dreaming or bare production stage.

Cost is high. Failure may have had something to do with the boating world's traditionalism. Foil craft "don't look like a boat," as skippers are fond of asserting. It may have been related to cost: The Supramar foil kit, installed on any powerboat, will carry a $400-plus price tag.

But no other foil comparable to the Swiss-developed Supramar has yet appeared. It is a sturdy, well-made unit, simply engineered and easily installed. It is doubtful if fishermen would go for it: Those foils are just something else to wrap a line around. The family runabout skipper might like hydrofoils; they'd take the bump out of his boating and cut his gas bill. Water-ski fans and skin divers could easily become buyers.

They'd like that ability to make speed in a chop or run all day with less fuel aboard, which add up to more boating fun for your money. ■ ■

wings. On approaching docks or other boats, don't forget those units that extend from the sides.

"Rivers" of Fresh

By harnessing the atom's mighty power, a great new U.S. desalting program aims at a history-making breakthrough—man-made fresh water so low in cost as to compete with nature's fickle supply

By Alden P. Armagnac

CAN man-made fresh water, distilled from the ocean's brine, slake the thirst of whole cities—and end drought-plagued regions' dependence on fickle rainfall? The answer is yes, experts say. Four years' operation of modest-sized U.S. seawater desalting plants has shown the way. Now comes the payoff.

A go-ahead from Congress has just launched a great new $185,000,000 federal program to develop city-size desalting plants, dwarfing any the world has ever seen. By harnessing the atom's mighty power, they are expected to achieve a history-making breakthrough—artificial fresh water at so low a cost that it will compete with the natural kind. Until now, it has been the high cost of desalting that has virtually barred the way to tapping the oceans' inexhaustible supply.

Too big for anything short of a national effort, the new U.S. program aims first at what it calls "intermediate"-size desalting plants producing 50 to 150 million gallons of fresh water daily—up to enough for the city of Boston—with construction of at least one such plant to begin by 1967. They make the 3½-million-gallon-daily output of the biggest desalting plant in the world today, on the Caribbean island of Aruba, look like a trickle. They will scale up, by at least 50 times, the one-million-gallon-a-day capacity of the biggest U.S. plants thus far.

From a brook to a river. Then, by the mid-1970s, will come "large" plants with a daily output of 500 million gallons—enough for a city as big as Philadelphia—and up. From them, instead of the brook-size flow of today's desalters, will come streams matching many a U.S. river.

All of these plants will be nuclear-powered, dual-purpose ones, producing vast quantities of electric power as well as fresh

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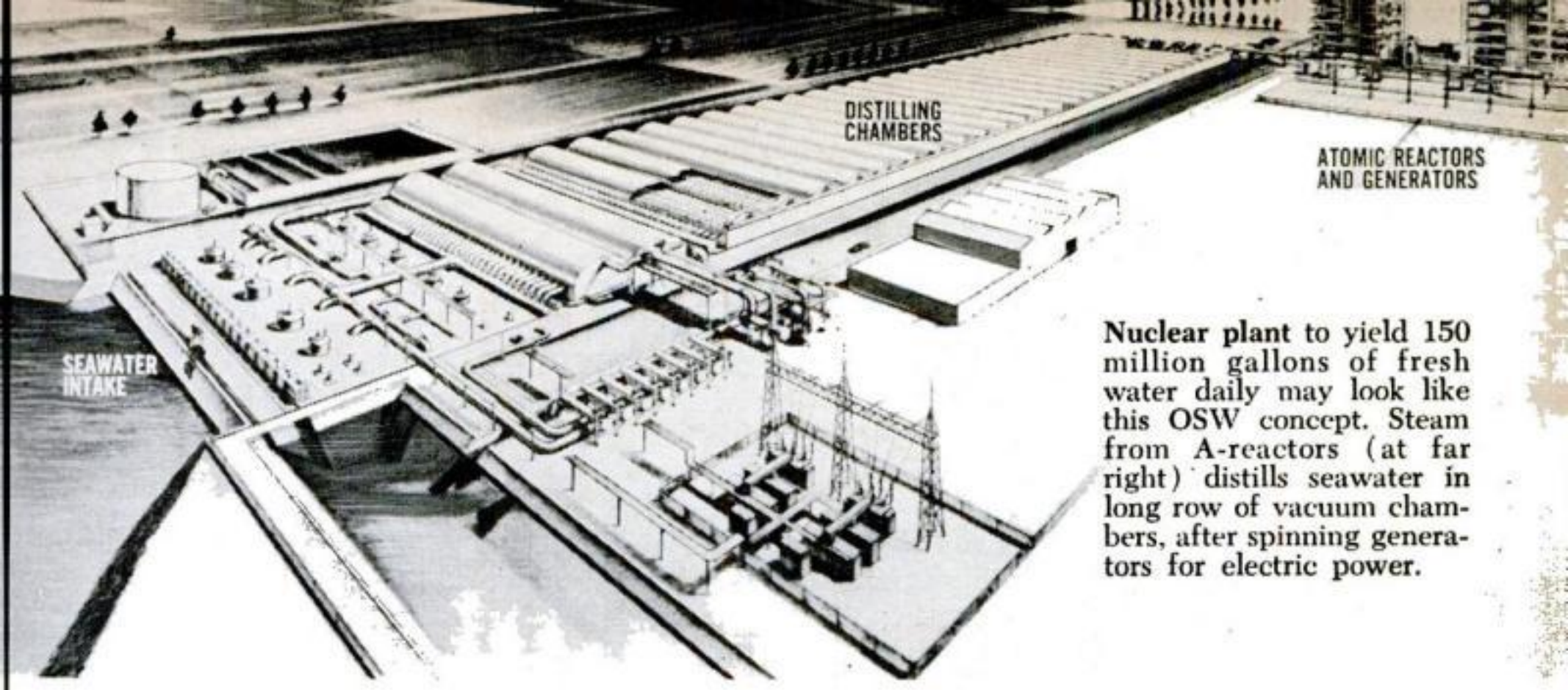
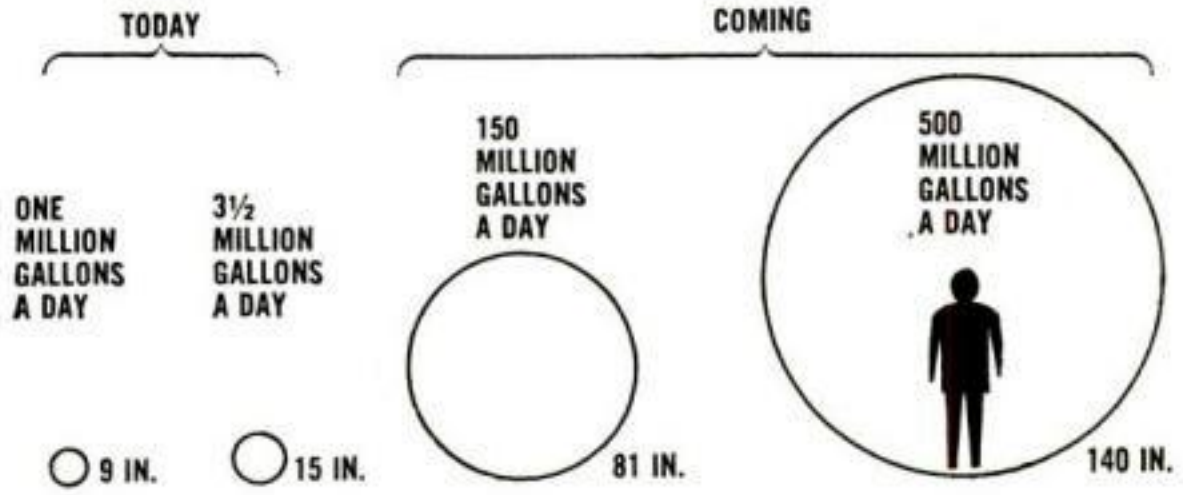


Nuclear plant to yield 150 million gallons of fresh water daily may look like this OSW concept. Steam from A-reactors (at far right) distills seawater in long row of vacuum chambers, after spinning generators for electric power.

Water from the Sea



Size of single pipe, appropriate to carry flow, graphically portrays capacity of present and planned desalting plants. Nine- and 16-inch pipes could handle output of biggest ones in the U.S., and in world, today. Rivers of fresh water from the coming plants would take pipes of 81- to 140-inch size.

water. Steam from their atomic reactors will spin turbogenerators on its way to providing heat to seawater distilling chambers resembling huge Quonset huts. The revenue from the sale of the electric power will slash the cost of the desalted water.

Designs for the city-size plants will be developed by the Interior Department's Office of Saline Water, the agency that has been conducting U.S. desalting research to date. The nuclear reactors will be designed for the OSW by the Atomic Energy Commission. With the help of these agencies, actual plants will be constructed by the cities or localities they will serve.

The Los Angeles area is expected to get one of the first city-size desalters. Jointly with the OSW and AEC, the Metropolitan Water District of Southern California recently commissioned a $492,000 study of a suitable desalting plant by the Bechtel Corp. Its preliminary report, now in, advises a 150-million-gallon-a-day plant, preferably on an artificial-island site offshore from Sunset Beach. The fresh-water output would supply a seventh of the area's needs. The cost, 22 to 30 cents per 1,000 gallons at the plant, would compare favorably with current costs in the region. Coupled to the plant's twin A-reactors, mighty generators would yield 1,800,000 kilowatts of electricity—more than the power generated at Hoover Dam.

New York City, its reservoirs so depleted by drought that only emergency water-saving measures are staving off total exhaustion, now is discussing with federal experts a droughtproof supply from a desalting plant yielding 250 million gallons a day—about one-fifth of the city's normal consumption. Such a nuclear plant would, besides, generate about 2½ million kilowatts of electricity. One proposed site would be on little Baruch Island, just off Staten Island in New York's Lower Bay.

Likely locations foreseen for other in-

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Our first desalting plants point the way to city-size ones

termediate or large desalting plants include the Texas coastline, between Houston and Corpus Christi; and the metropolitan area of northern New Jersey. The cost of fresh water from large desalters, 20 to 25 cents per 1,000 gallons at the plant, could have a sizable allowance for distribution tacked on—and still match the average cost of water in U.S. cities.

Extracting fresh water from the sea goes back to earliest times—but the high cost of desalting, until now, has confined its use to places where natural fresh water is exceptionally hard to get. Last year a world survey counted just 35 seawater-desalting plants having a daily capacity of 50,000 gallons or more. All told, they produce 32½ million gallons a day—about enough to supply a moderate-size U.S. city like Hartford, Conn., or Savannah, Ga. Most of them do it by distilling the ocean brine, the method long used on shipboard to obtain drinking water and replenish the vessel's boilers.

Three U.S. demonstration plants have been contributed to this list since 1961 by the Office of Saline Water, created in 1952 to advance the technology of desalting. Seawater desalters at Freeport, Tex., and Pt. Loma, Calif., each of one-million-gallon-a-day rating, have tested different versions of distilling processes. A 200,000-gallon-a-day plant at Wrightsville Beach, N. C., freezes seawater to recover the pure-water ice crystals. Meanwhile, OSW demonstration plants at Webster, S. D., and Roswell, N. M., have tackled the problem of freshening brackish local water—a task exactly akin to desalting seawater, except for the smaller amount of salts to be removed. Although operating on so modest a budget that it has spent only $55,000,000 in its 13 years, the OSW has already accomplished these big feats:

- From a former $5, it has reduced to $1 the present cost of 1,000 gallons of man-made fresh water from the sea, at its Freeport and Pt. Loma plants.
- The best desalting method for the big plants now planned, it has shown, is the one used at Pt. Loma—"multistage flash distillation," in which vacuum chambers lower the seawater's normal boiling point.
- The value of desalting to national defense has been dramatically illustrated. When Cuba's Fidel Castro sought last year to harass our Guantanamo naval base by cutting down its supply of Cuban water, the decisive U.S. retort was to saw its pipeline in two, and transplant the Pt. Loma desalter to Guantanamo to serve the base. Added units have since boosted the output of the Guantanamo desalter to a copious 2½ million gallons daily. Its former California site is to get an improved replacement.

Now—nuclear desalting. Like the oil-fired Pt. Loma plant, all the world's sizable desalters have used conventional fuel for heat. Last year a major Government study concluded that the cost of desalting could be drastically reduced by a nuclear plant, with electricity a by-product. The bigger the dual-purpose plant, the more economically it would operate—opening the way to desalted water as inexpensive as natural fresh water. To achieve the breakthrough, President Johnson called upon the OSW to draw up an "aggressive and imaginative" new program—and the one just okayed by Congress is the result.

An early OSW step will be to construct a Pacific-coast test station, which itself will have a record-setting desalting capacity of 15 million gallons daily. Here experts will try out full-scale modules, or sections, of the larger plants to come, and their components.

A-reactors for the coming plants are called further along than the desalting equipment. A 150-million-gallon-a-day desalter could use any of several proven types of civilian power reactors—and the reactor's size need be no larger than that of some of the biggest now being built.

Giant A-reactors for the longer-range plants of 500 million gallons a day, and more, remain to be developed. The kind the AEC now considers the most promising—because unlimited in size—is a new and exotic one. So far, it is represented only by a medium-size reactor at Canada's Whiteshell Nuclear Research Establishment in Manitoba. It uses the novel combination of heavy water as a moderator and, as a heat carrier, an "organic coolant"—in the Canadian version, a commercial preparation called Santowax-OM. A granulated honey-colored solid at room temperature, it melts and flows like molasses in the reactor's heat. AEC researchers have arranged to share the use of this Canadian reac-

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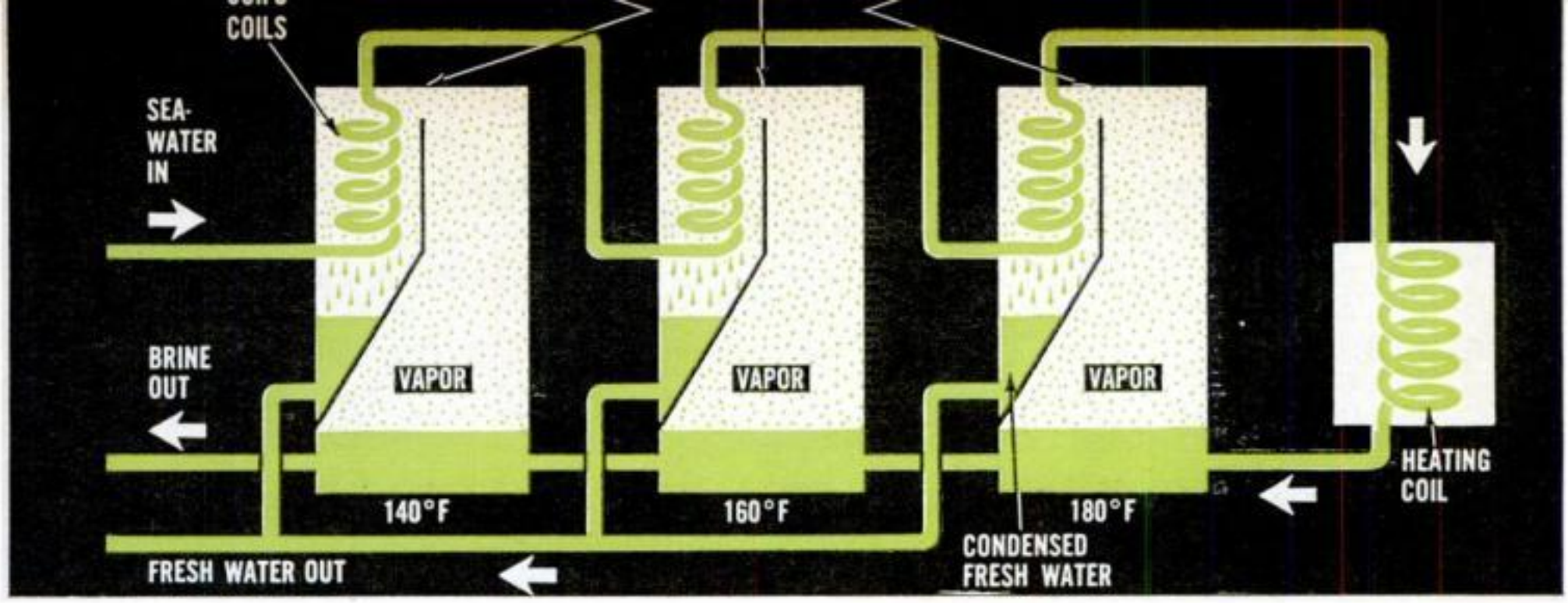
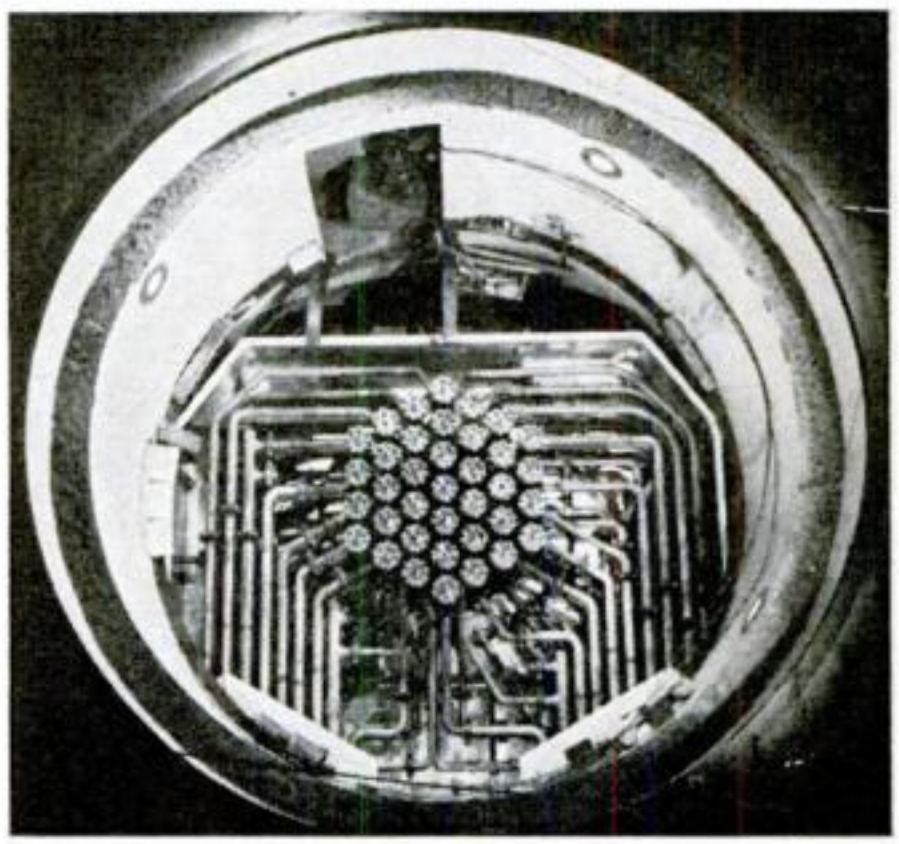


Favored desalting method for city-size plants is multistage flash distillation, of which diagram shows principle. Preheated seawater is raised by heating coil to temperature at which it flashes into vapor, on entering successive vacuum chambers, and condensing fresh water is piped off. Heating coil draws its heat from steam supplied by boilers, which may either be fired with conventional fuel or heated by A-reactors.



Key to biggest desalting plants now is held to be a scaled-up version of new Canadian atomic reactor (right), which will serve visiting U.S. A-men for design studies. First of kind, it uses novel and promising combination of heavy water as a moderator, and an organic coolant—circulating through close-packed tubes at center—as a heat-carrying medium. Reactors of this kind would be unlimited in size.

tor, and study how to scale up its design.

On the way to the OSW's city-size plants will come more immediate developments in desalting, outside the Federal program:

New York State's own atomic agency sponsors a nuclear desalting plant due for completion in 1968 at Riverhead, N.Y., on Long Island. It will produce one million gallons of fresh water a day, 2,500 kilowatts of electricity, and radioisotopes of the kind used in atomic batteries for spacecraft. The current will be sold to the Long Island Lighting Co.; the water, to the Riverhead Water District, at 35 to 45 cents per 1,000 gallons. In answer to doubters that so small a plant could desalt water at so low an actual cost, the State agency insists that the sale of the radioisotopes will make it possible.

Big drink. A 2½-million-gallon-a-day desalting plant for the Florida keys will become the country's biggest, with its scheduled completion next year. It won the nod over a 10-million-gallon-a-day dual-purpose nuclear desalter that had been under study for the same area by the OSW and AEC.

Federal planners are well aware, however, of a need for smaller-than-city-size desalters in many localities here and abroad, where the big ones' output of water and electricity would be excessive. Concurrently with large-scale plans, the OSW program is therefore developing improved and more economical versions of small desalters. For these, it pins great hope on a relatively new heatless method of desalting—called "reverse osmosis" or "ultrafiltration"—in which the only energy consumed is for pumping salt water through porous membranes to freshen it. Following the success of a 1,000-gallon-a-day pilot plant at Azusa, Calif., a 25,000-gallon-a-day experimental plant is being designed for operation in 1967.

Today there are places on earth where water is so scarce and precious that a man may be shot for drinking from another's well. By sharing with the world its findings of how to tap the sea for fresh water, the U.S. is bringing nearer the day when there will be plenty for all. ■■

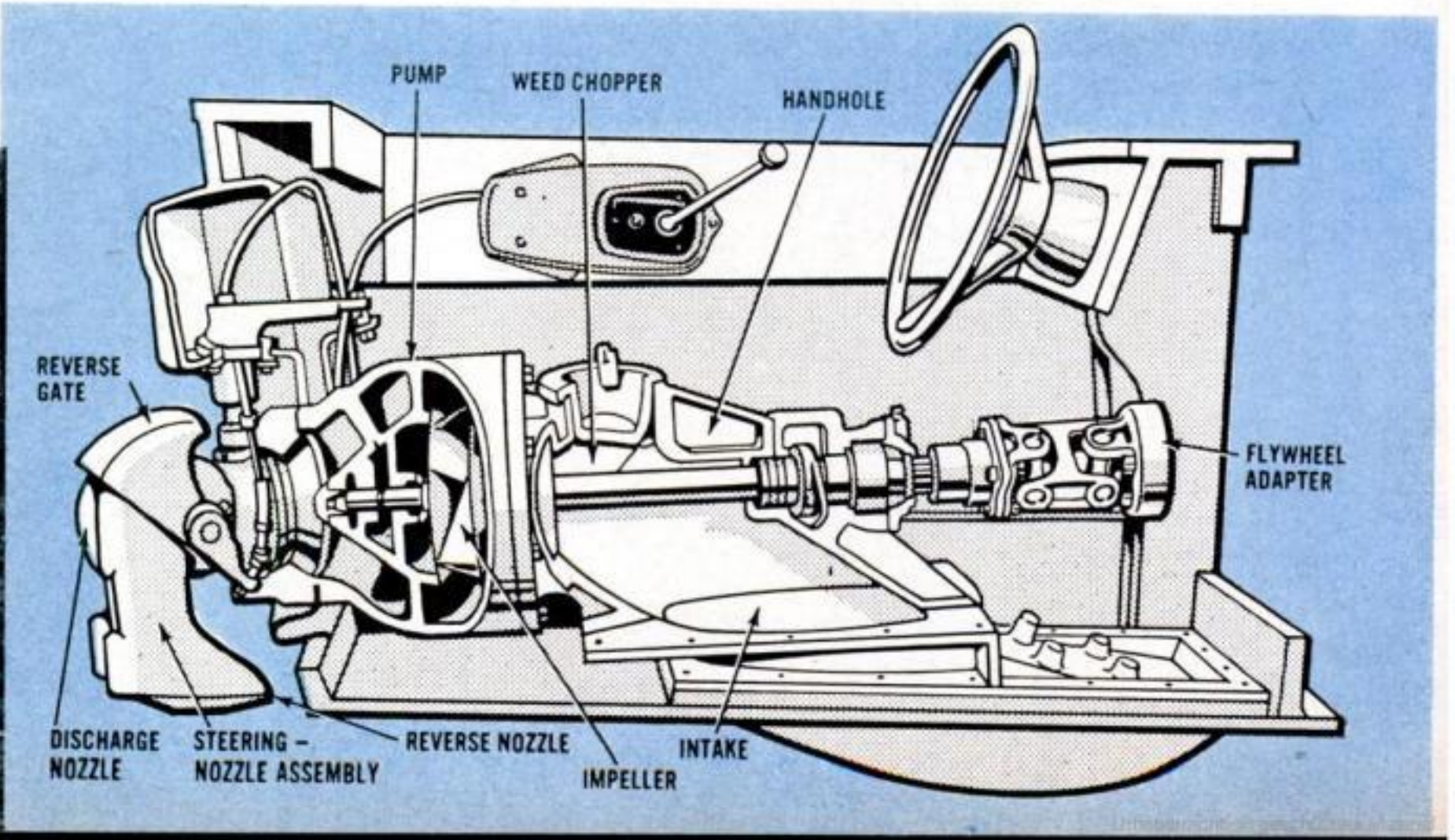
Urheberrechtlich geschütztes Material

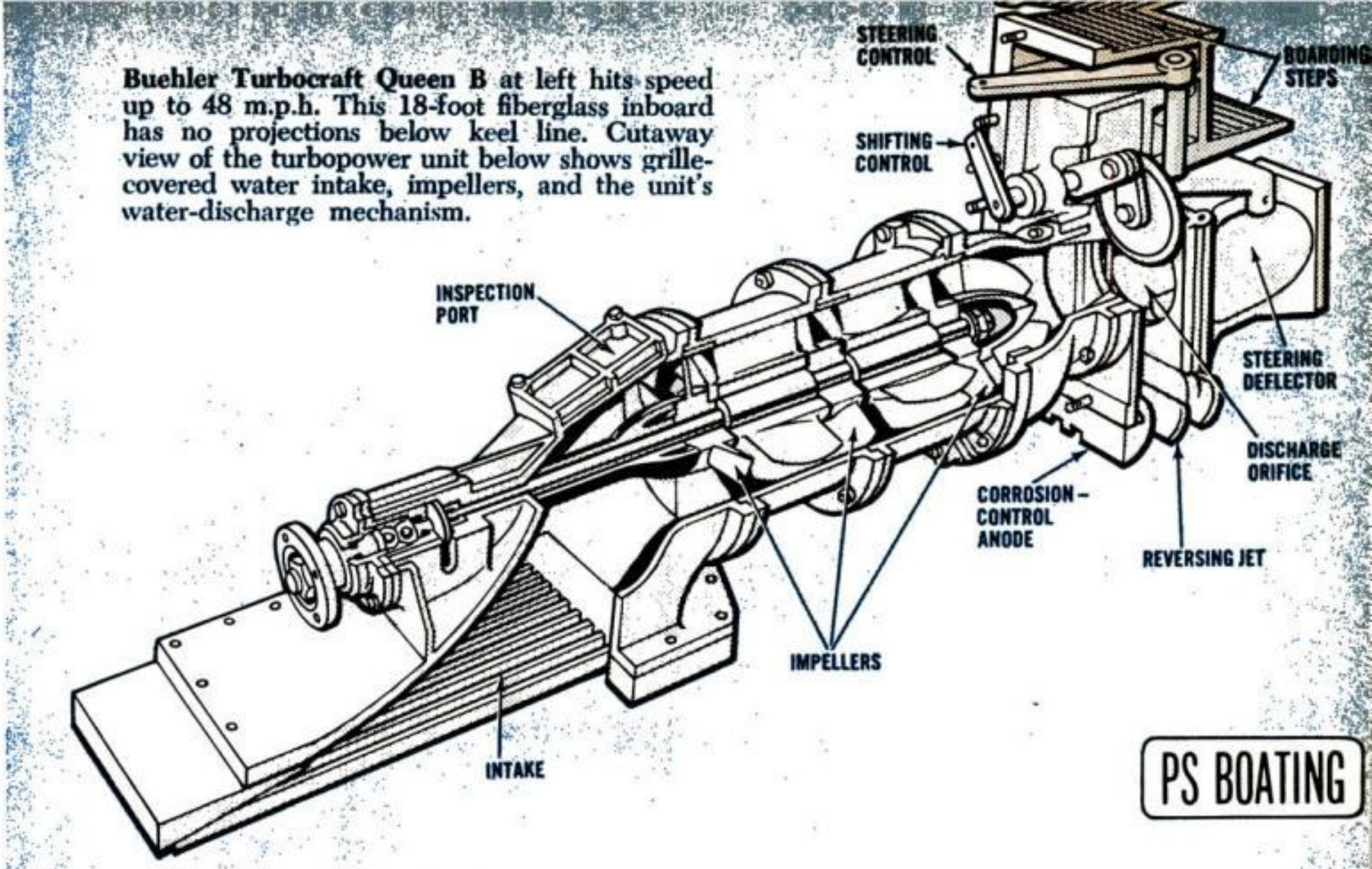
Pros and Cons of Jet

Want to ride a jet stream? Jet enthusiasts love the speed and ability to navigate shoal water

By Jim Roe, Boating Editor

NO QUESTION about it. The most vulnerable thing on a boat is its propeller. Alone and for the most part unprotected, it whirls along out of sight but never out of mind. And all too often it tries to bite off more than it can chew, in the form of deadheads, rocks, and





Buehler Turbocraft Queen B at left hits speed up to 48 m.p.h. This 18-foot fiberglass inboard has no projections below keel line. Cutaway view of the turbopower unit below shows grille-covered water intake, impellers, and the unit's water-discharge mechanism.

Power for Small Boats

mudbanks. It can be tragically dangerous.

The solution is at hand, say the proponents of jet power for small boats. All you need, they say, is a hungry pump that gulps up several thousand gallons of water a minute and shoots it out the rear at speeds of 75 m.p.h. or better. This wide-open fire hydrant in the stern of your boat then proceeds to prove the truth of Newton's third law of dynamics which states that for every action there is an equal and opposite reaction. Your boat goes forward—fast.

Jet-propelled boats offer several very solid advantages, have some disadvantages, and

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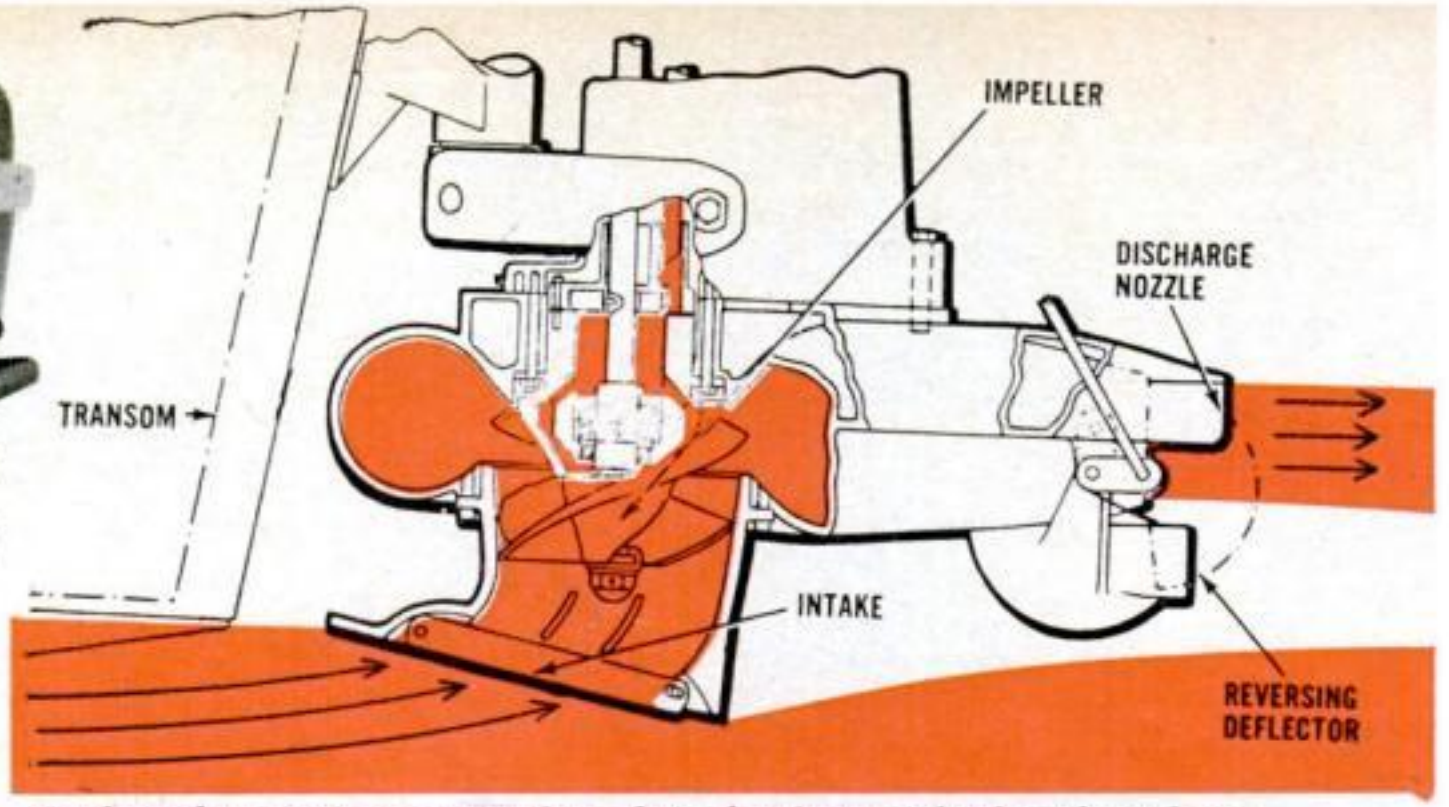
Berkeley Jet Pump took us safely and speedily through the marine flower garden below. Secret here is to maintain a rapid speed, so pump will chop up any vegetation it inhales. Sketch at left shows operating mechanism of the jet pump, including movable cap at rear which drops down to deflect water forward, providing reverse thrust. Dropping gate provides a brake.



Outboard jet unit consists of jet-drive kit for standard outboard motors from 25 to 50 hp. Made by Outboard Jets, this unit draws water in slightly angled intake, expels it out stern orifice. It will operate in water only three inches deep. Unit swivels to provide steering.

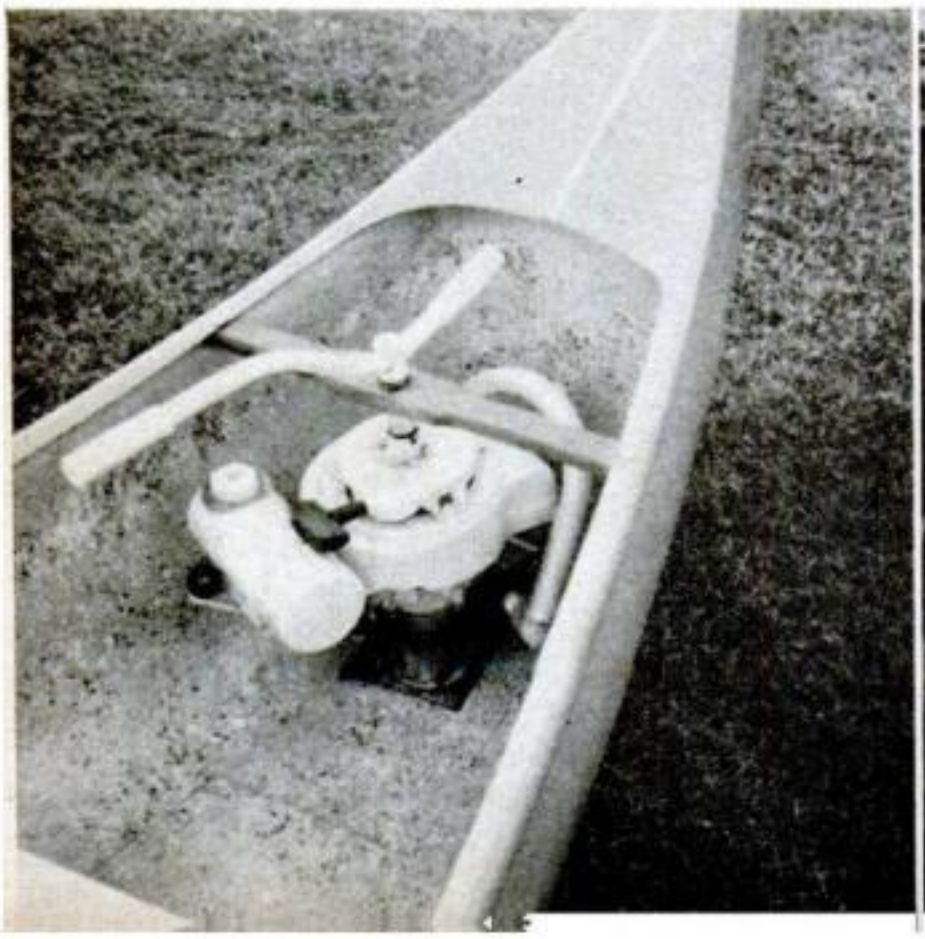
are different from prop-driven boats in some ways that appeal to certain people and do not appeal to others.

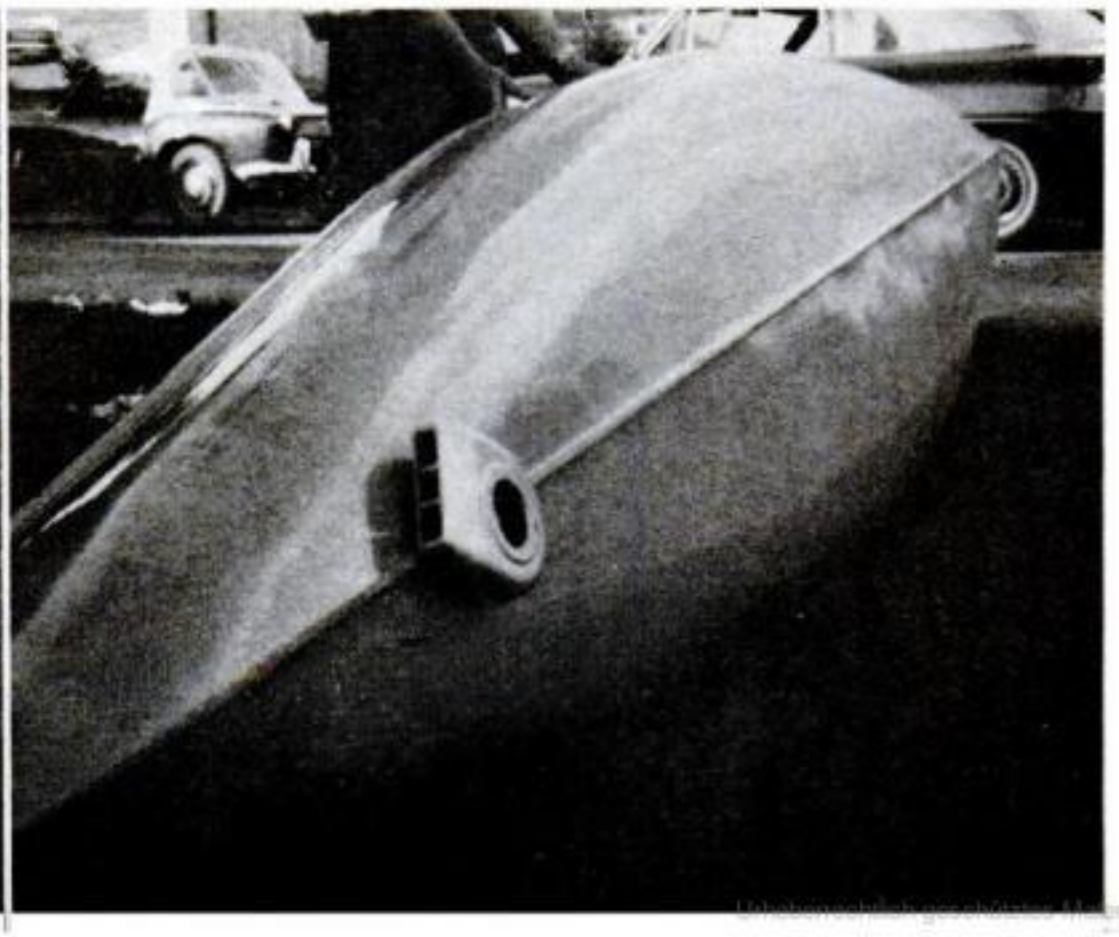
One of the two major advantages of jet propulsion is the virtual elimination of all the troubles propellers get into. The typical jet-powered boat has nothing extending below the hull line. The water intake is recessed flush with the hull, and the discharge unit at the stern is at or above the surface of the water.

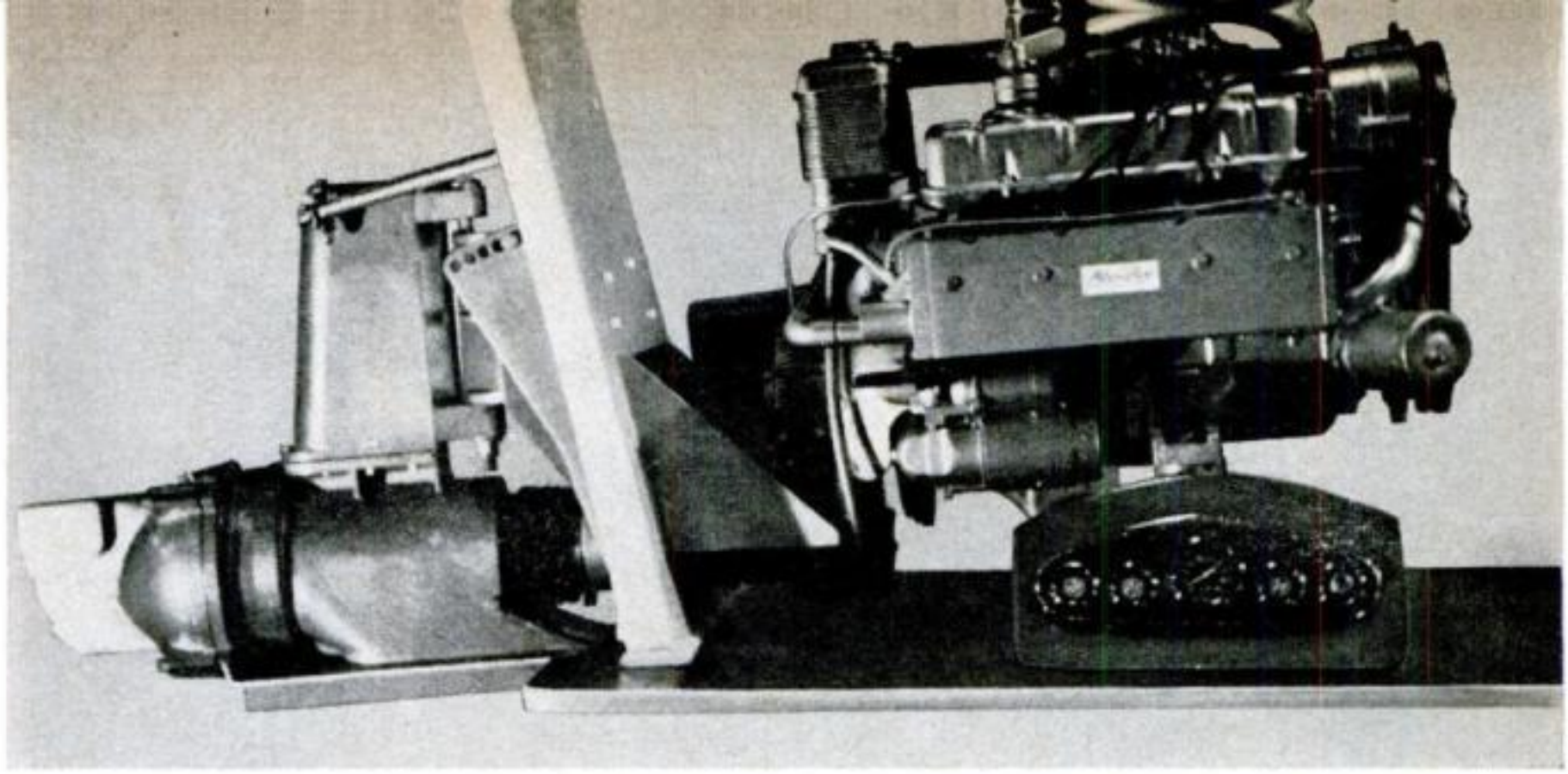
So a jet boat can sail happily over sandbars, thread its way among rocks, and navigate right up to a beach. As long as the pump can get a good drink of water, it will operate anywhere the boat will float.

On the plus side. The second major advantage of jet-propelled boats is their safety to swimmers. No whirling set of blades is exposed to hurt an unwary swimmer. As a matter of fact, several jet-propulsion units have boarding steps as integral built-in features—though it takes a lot of psychological adjustment to approach the stern of such a boat while the engine is running and nonchalantly climb aboard. Some other advantages claimed for jet boats include their ability to throttle down and troll at almost any speed, easier launching and recovering from a trailer or beach, ability to plow through weed-infested waters, ability to make sharp turns at high speed. Also, there are fewer moving parts and thus theoretically less wear and tear than with the normal propeller setup.

Here's an inboard canoe: This hydrojet unit has 2½-hp. motor, with centrifugal jet power plant mounted outside the hull, below the keel. The entire unit weighs only 20 pounds. Power system runs five hours on one gallon of gas, extends only two inches below the keel. The unit can be mounted in your own canoe. Motor has 360-degree steering radius with inside control.







REV-Jet shown above is an inboard/outboard jet-propulsion unit for small boats. The front-end mechanism projects less than two inches below the bottom of the hull. The water inlet is in a stern-mounted unit, so that only the jet-engine's drive shaft projects through the boat's transom. Horsepower of units now on the market ranges from 150 to 260.

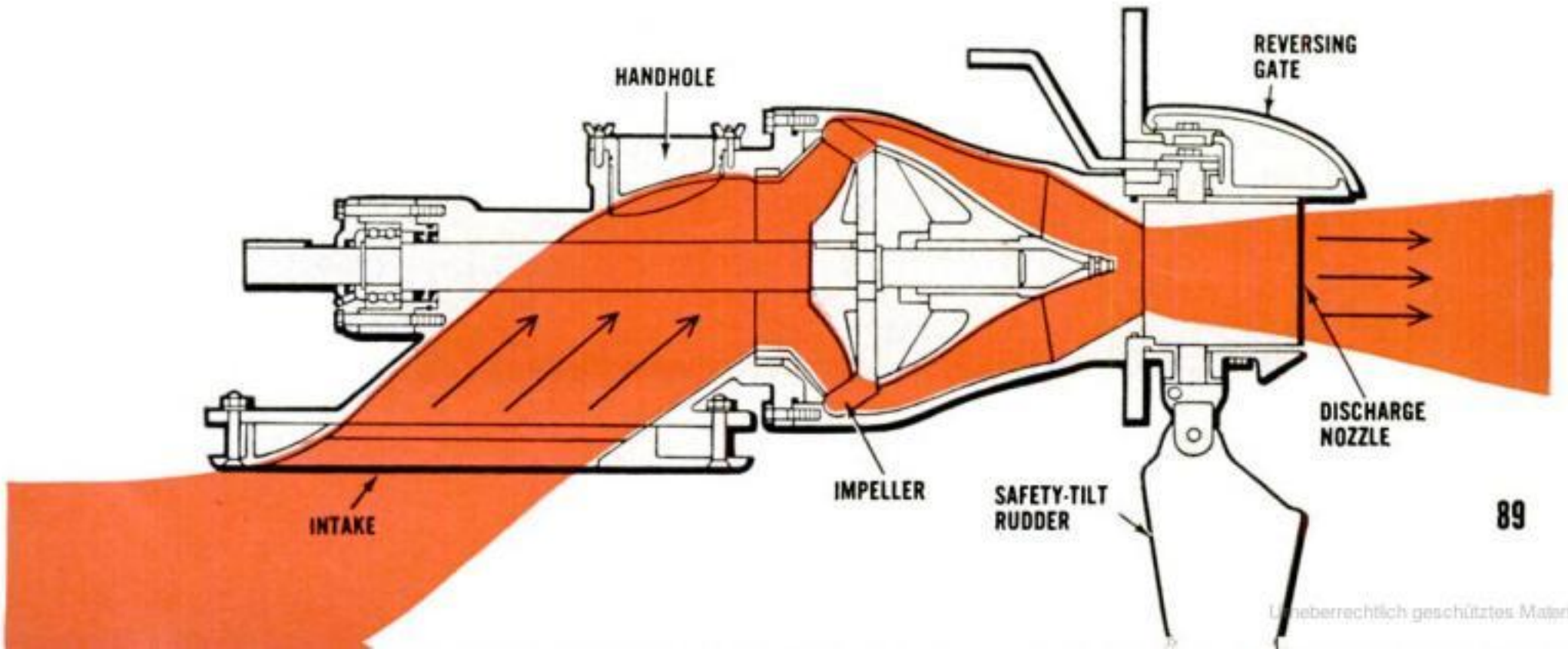
There are problems, too. One is that a good many of the jet-powered boats are more difficult to maneuver at slow speeds than propeller-driven boats. Maneuverability depends upon the discharge of a good-size and powerful flow of water. When the flow is small, and at a slow speed, its effect is minimal. Some jets have rudders to give greater control at low speeds.

Another problem with jet drives is efficiency and speed. This is by no means a clear-cut, black-and-white situation, since the results depend a lot on hull design and other factors. Some tests show that a jet-propelled boat engine needs to be turning at 2,800 to 3,000 r.p.m. to equal the speed through the water of a propeller-driven boat whose engine is only turning from 1,800 to 2,000 r.p.m. And sometimes both the efficiency and top speed of a jet-propelled boat are less than that of a propeller-driven boat. In hulls well suited to jet drive, however, the top speed is often actually better than with a prop drive. Depending on its installation, a jet at top speed can usually give performance and economy comparable to a conventional outdrive. In the midranges, this is often not quite the case.

Drive through a flower garden? One whole set of problems that are chalked up as disadvantages of jet propulsion grow out of misuse of the jet's actual advantage. One of these is boating through weed-filled waters. You wouldn't think of heading through a thick patch of lily pads with a propeller-driven boat, but with a jet you're apt to get a smug look on your face and

[Continued on page 199]

Jacuzzi Marine Jet is shown in the drawing below in forward operation. Water is being drawn up through the intake at the bottom; impellers expel it at high pressure past the steering vane. When the curved reversing gate is dropped, water flows down and forward, propelling the boat from the rear. The rudder is spring-loaded, tilts up for obstructions.



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VALIANT has minor changes only for 1966. It's tops in handling, has lively slant-six.

RAMBLER AMERICAN is longer overall but is still cramped in useful interior space.

REPORT FROM THE DRIVER'S SEAT

Comparing the Compacts:

In a candid analysis of all four of the compacts our expert critic says that two are outstanding buys

By Jan P. Norbye, Automotive Editor **Exclusive Photos by Bill Morris**

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FALCON is *the* wide-track compact now. It's a completely new car with Fairlane flavor.

CHEVY II has more room than Rambler but less than Falcon. Ride comfort is good.

VALIANT·FALCON·AMERICAN·CHEVY II

WHO buys compact cars? During the first six months this year, 656,330 people did. After having tried the '66 models, I think there will be many more of them next year.

Why do people buy compact cars? There are many economical advantages: The initial purchase price is lower, fuel mileage is better, repair work and replacement parts cost less, and there's even a small saving on insurance premiums.

But I suspect that the people who buy compacts do so because they *like* them; not because they cost less to buy and keep.

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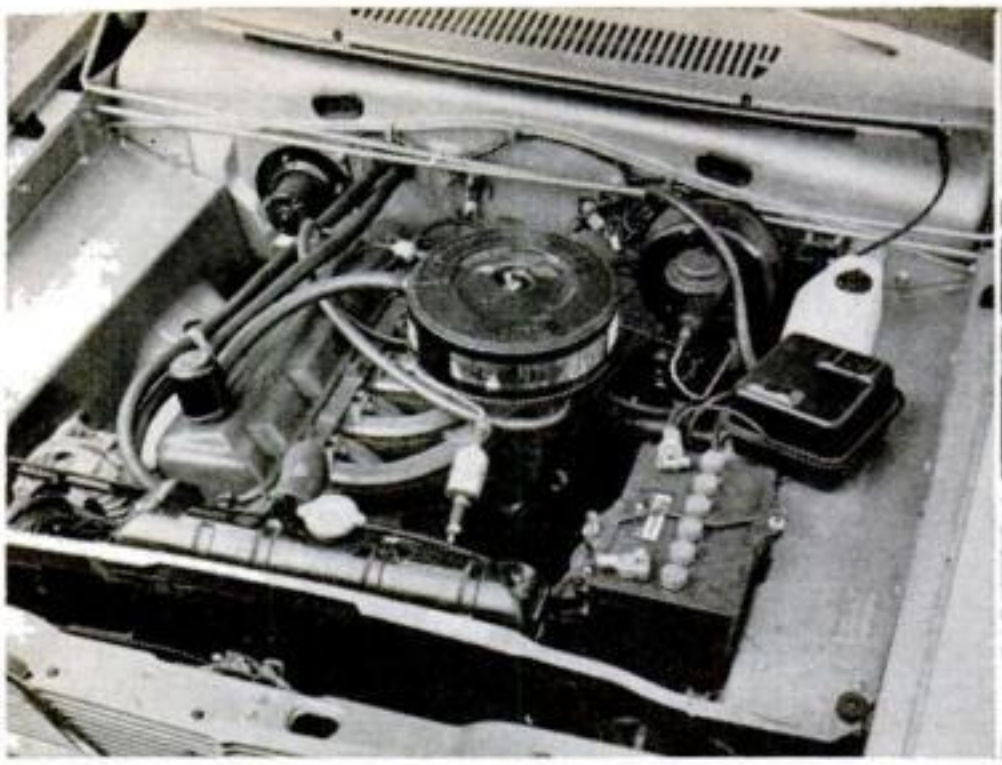
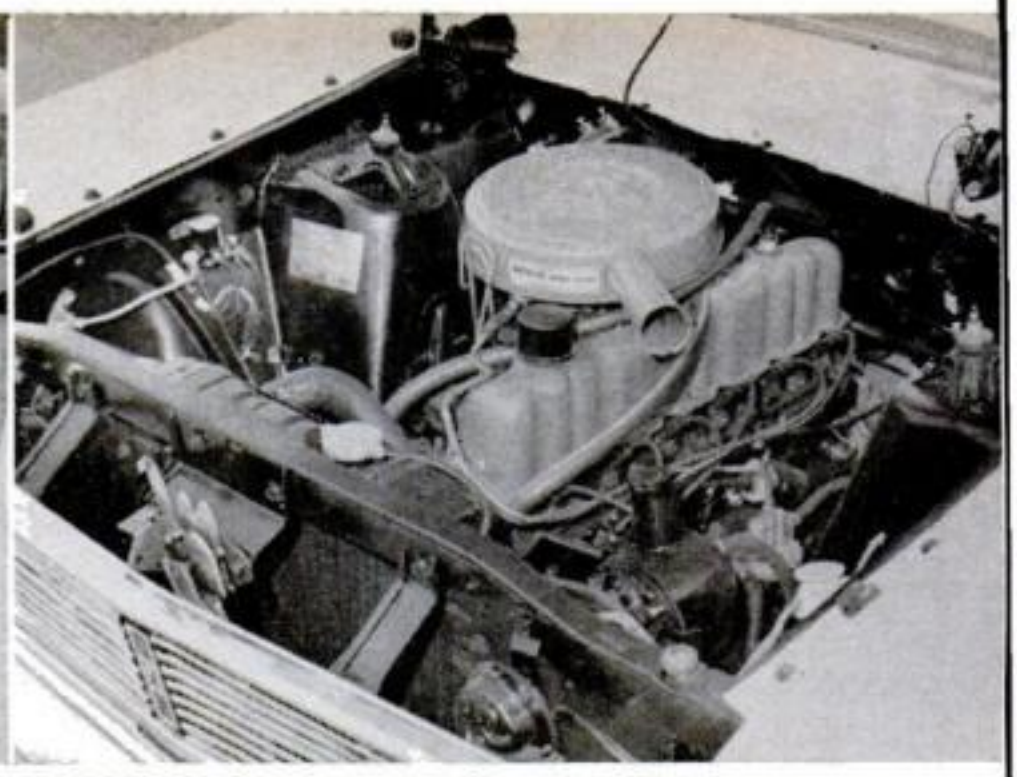


VALIANT's slant-six with four main bearings may be obsolete but it offers pretty good performance. It's also remarkably quiet and free from vibration.



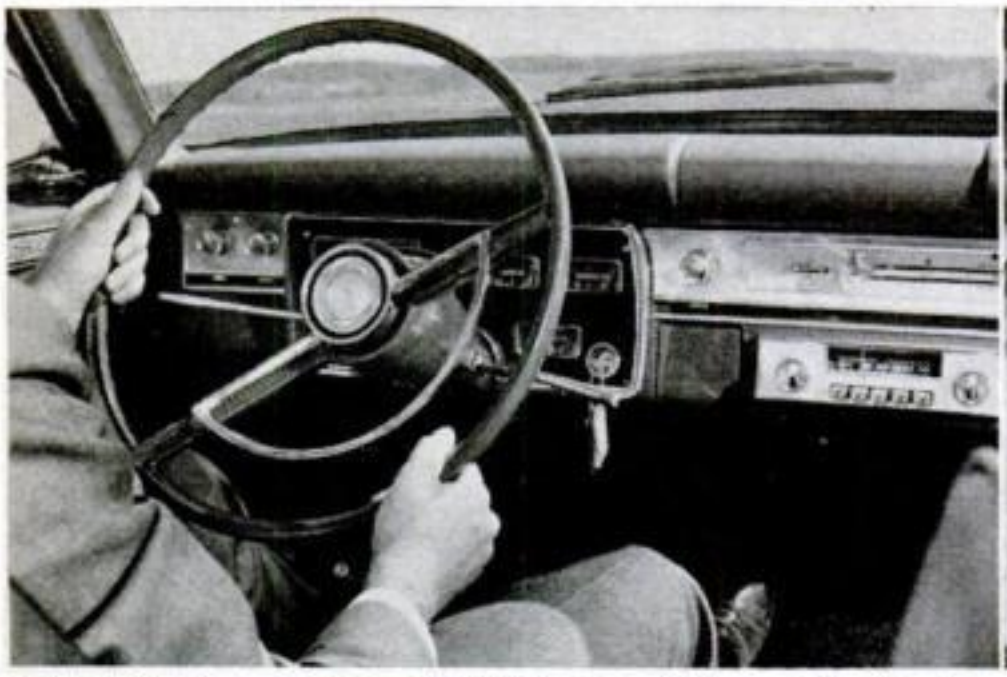
FALCON has a seven-bearing 200-cu.-in. engine, developed via the standard four-bearing 170, from the Falcon's original 144-cu.-in. six.

If you decide a compact car's for you, the difficulty lies in picking the right one. The Chevy II has the most engine options, only the Valiant is available with disk brakes, the Falcon is the roomiest and most comfortable, and you'll find the highest-quality finish on the Rambler.

Chassis design. It is basically similar on all four. The Valiant has Chrysler's torsion-bar front suspension, but the three others have transverse control arms and coil springs. Falcon and Rambler place the coils on top of the upper arm with the top anchored in the body structure; Chevy II also carries the coils on the upper control arms. In the rear end, all have semielliptic leaf springs. But while Ford, Chrysler, and American Motors use four or five leaves, the Chevy II has a tapered single-leaf spring; thin and flat at the extremities, almost square-sectioned where it's bolted to the axle housing.

Ride comfort. On good roads, both the Falcon and the Chevy ride almost like big cars. The Valiant ride seems harder, but even with its short wheelbase, there's no pitch problem. The American has the same 106-inch wheelbase and less front overhang, but the ride can sometimes be quite choppy. There is some brake dive on all of them, but I wouldn't call it objectionable. On abrupt starts from standstill, they tend to squat at the tail, but the Valiant does it less than the others. For all-around use, the driver would be happier in the Valiant, while his passengers would probably prefer the ride of the Falcon or the Chevy II.

Steering response. Despite its high steering ratio, the Chevy II responds to the wheel in a very positive way. The Falcon,



VALIANT has a pleasant driving position with plenty of leg room. The instrument cluster is adequate, but the speedometer should be more legible at a glance.

FALCON has the most comfortable driving position and more leg room and width than any other compact. Instruments are round.

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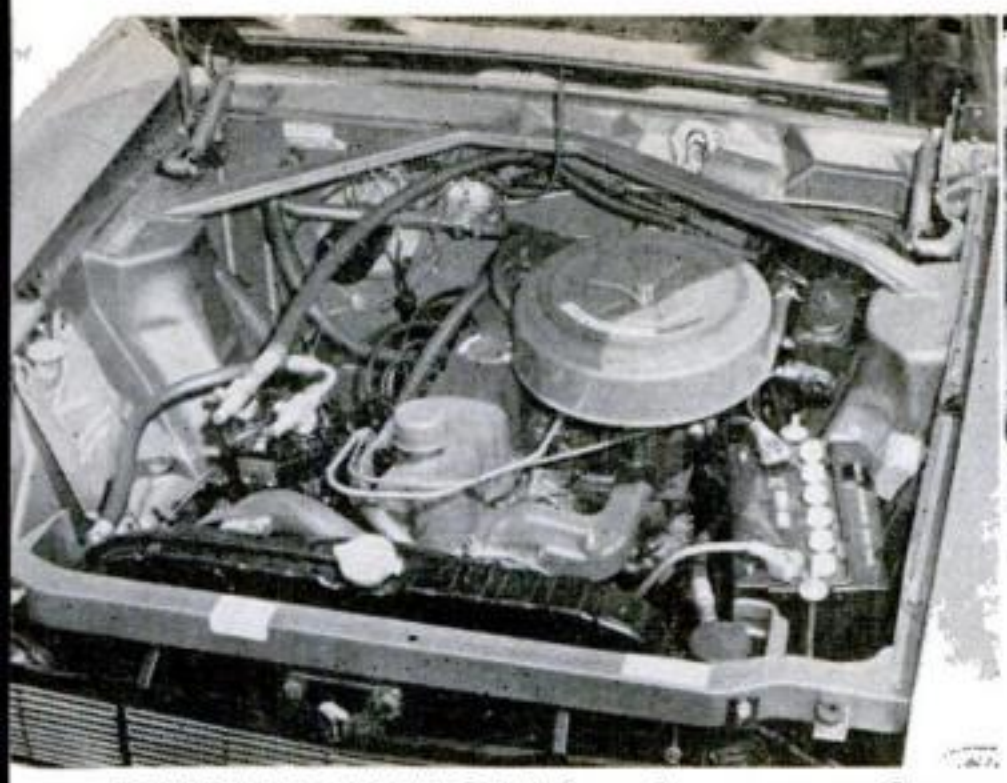
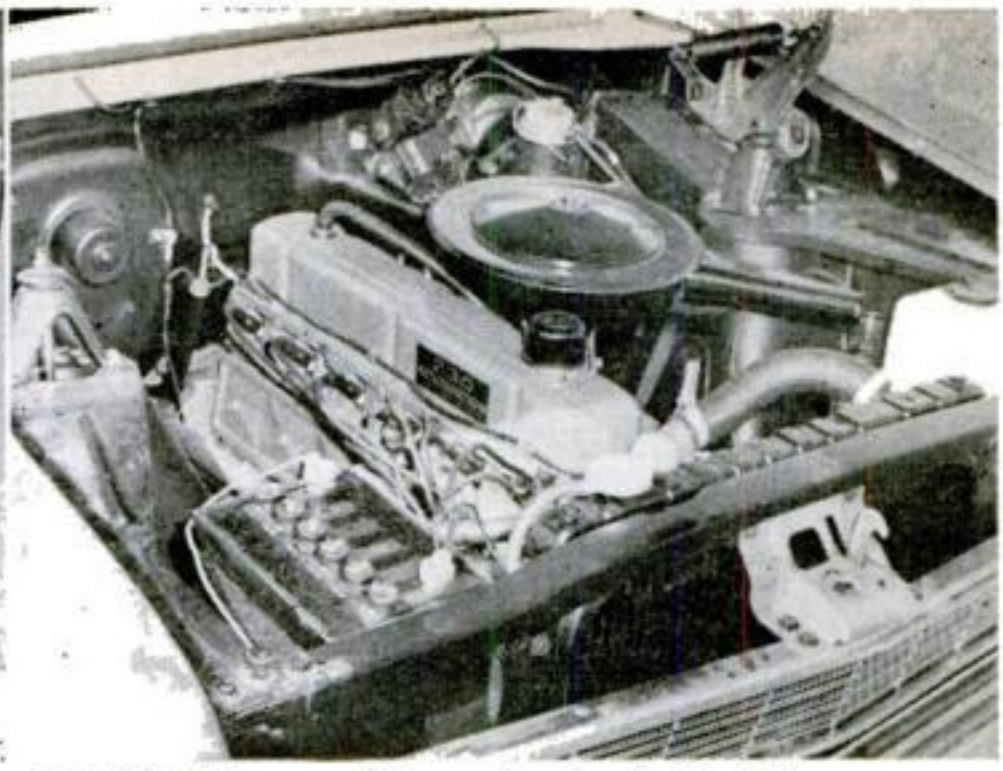


RAMBLER AMERICAN has the most modern engine in the group: a lightweight, well-balanced, short-stroke seven-bearing power unit.



CHEVY II has a 230-cu.-in. six derived from seven-bearing 194-cu.-in. six designed for the first Chevy II (1962 model). It is a smooth and willing unit.

on the other hand, has a small steering lag whenever you deviate from a straight course. While it's a good thing that the car resists all outside forces trying to deflect it from a straight line, impulses from the steering wheel should have immediate effect.

The Valiant has a new power-steering unit that reduces the assist at high r.p.m., so that you get a better road feel at highway speeds. Conversely, at low r.p.m., such as when parking or maneuvering, power assist is high. This is a sound principle, and I only wish they had taken it a lot further. Even in its present form, however, the Valiant has the best steering response. The American's steering, on the contrary, seems particularly "dead" at speed. As this car is also highly sensitive to crosswinds and tends to wander in gusty weather, the lack of feel in the steering wheel is a problem and one of my beefs with Rambler.

Stability on turns. The wide track on the new Falcon works wonders for the car. The front suspension was redesigned with a higher roll center to take full advantage of its 58-inch track. The new car has none of the wishy-washy feeling of the old Falcon. On high-speed turns, it leans a bit, but it doesn't mind being driven hard—the old one always gave signs of wanting to corner on the door handles. The rear leaf springs are both wider and longer, giving a softer ride on small bumps as well as better stability on turns.

High roll stiffness has been built into the Chevy II chassis, but one of the penalties for relatively flat cornering is restricted vertical wheel movement. So, on really hard and fast turns, you lift the inside rear

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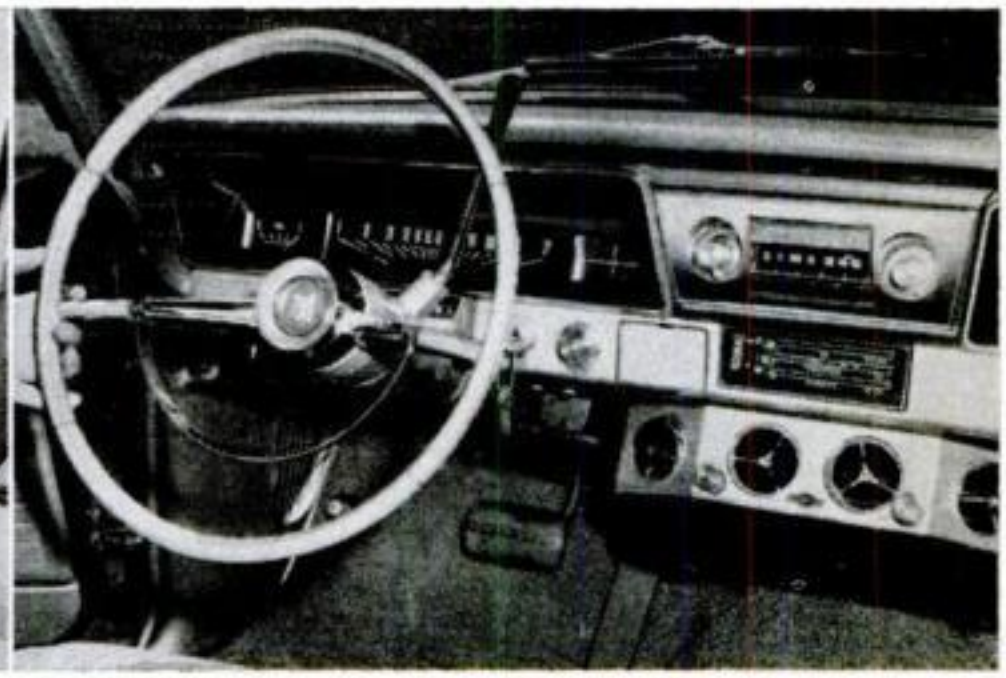
RAMBLER AMERICAN offers the driver cramped quarters. Instrumentation is as comprehensive as Valiant's, the speedometer more legible.



CHEVY II is roomier than the Rambler, but I was not very comfortable at the wheel. It's sad they didn't copy Impala's seat-to-wheel-to-pedal relationship.

Urheberrechtlich geschütztes Material

wheel, and the car loses traction just when you need it most.

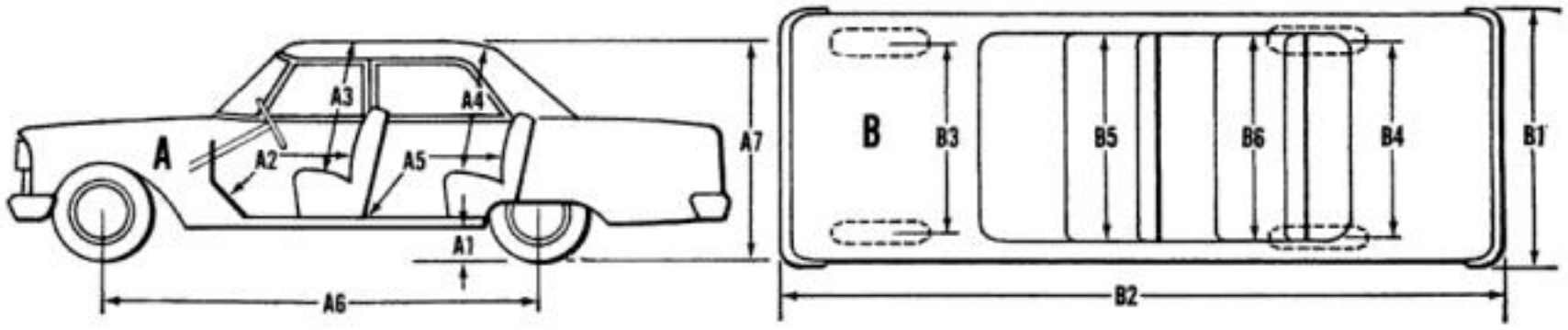
Rambler has a similar problem, but lifting the inside rear wheel on the American is accompanied by more body roll (in standard form, this car has no stabilizer) and greater slip angles on the front wheels. It's very difficult to get around turns fast with the Rambler—handling precision is very poor, and if it's a bumpy right-hander, you end up several feet left of where you want to be.

Even with stock suspension, the Valiant has better stability on turns than its rivals. Body roll is slight and balance is unimpaired by fast cornering. It goes through S bends with less fuss than any of the others. It never plays any tricks on you.

Special suspensions. If handling precision means everything to you and ride comfort very little, you might want your Valiant with Rally Suspension. It consists of heavy-duty leaf springs, larger torsion bars, special shock absorbers and a reinforced stabilizer bar. Rambler American has a handling package made up of a front stabilizer bar and special shock absorbers. For the Chevy II, the only suspension option is special shock absorbers (but stronger springs are used with each engine option). The Falcon has no suspension option (and the Mustang parts won't fit).

Power trains. We tested the compacts

[*Continued on page 184*]



DIMENSIONS (inches)	PLYMOUTH Valiant	FORD Falcon	RAMBLER American	CHEVROLET Chevy II
A1 Ground clearance	5.5	5.9	6.0	5.2
A2 Front leg room	39.9	42.1	41.0	40.7
A3 Front head room	38.2	38.8	39.3	38.8
A4 Rear head room	37.2	37.7	37.0	37.3
A5 Rear leg room	35.0	33.9	36.5	36.2
A6 Wheelbase	106.0	110.9	106.0	110.0
A7 Overall height	53.5	54.5	54.5	55.1
B1 Overall width	70.1	73.2	69.5	71.3
B2 Overall length	188.2	184.3	181.0	183.0
B3 Front track	55.6	58.0	56.0	56.8
B4 Rear track	55.6	58.0	55.0	56.3
B5 Front-seat width	56.9	59.5	57.2	59.2
B6 Rear-seat width	57.0	59.5	57.1	58.6

SPECIFICATIONS

Engine type	OHV Six	OHV Six	OHV Six	OHV Six
Bore & stroke	3.40x4.125	3.68x3.13	3.75x3.50	3.875x3.25
Displacement	225 cu. in.	200 cu. in.	232 cu. in.	230 cu. in.
Compression ratio	8.4:1	9.2:1	8.5:1	8.5:1
Carburetion	Single 1-bbl.	Single 1-bbl.	Single 1-bbl.	Single 1-bbl.
Power & r.p.m.	145 @ 4,000	120 @ 4,400	145 @ 4,300	140 @ 4,400
Torque @ r.p.m.	215 @ 2,400	190 @ 2,400	215 @ 1,600	220 @ 1,600
Transmission	TorqueFlite planetary 3-speed & torque converter	Cruise-O-Matic planetary 3-speed & torque converter	Flash-O-Matic planetary 3-speed & torque converter	Powerglide planetary 2-speed & torque converter
Axle ratio	3.23:1	3.20:1	3.31:1	3.08:1
Tire size	6.50x13	6.50x13	6.45x14	6.50x13
Steering ratio	18.8:1	21.4:1	21.2:1	25.4:1
Turns (lock-to-lock)	3.5	3.5	4.3	4.5
Turning radius	18.6 ft.	19.4 ft.	18.0 ft.	19.2 ft.
Brake-swept area	254.5 sq. in.	212 sq. in.	226.2 sq. in.	268.6 sq. in.
Curb weight	2,690 lb.	2,675 lb.	2,700 lb.	2,745 lb.

PERFORMANCE

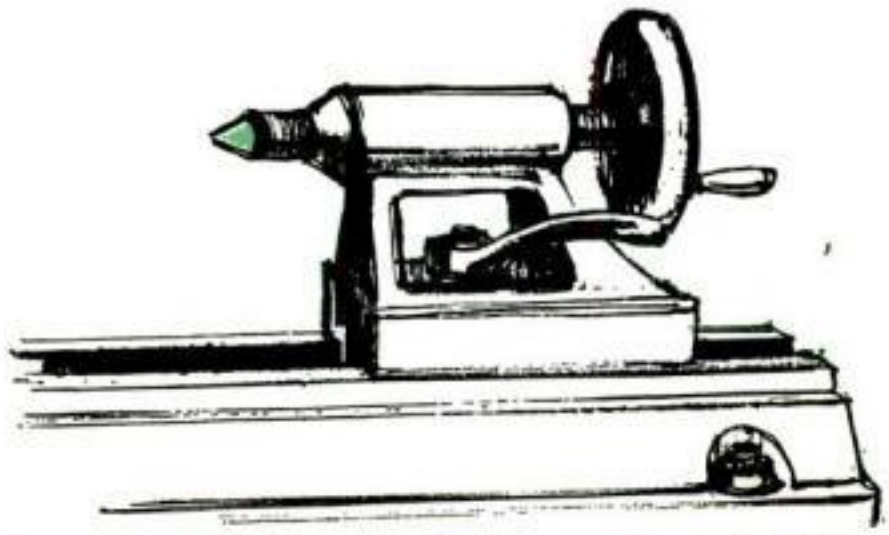
0-60 m.p.h.	12.2 sec.	13.0 sec.	12.0 sec.	12.7 sec.
0-80 m.p.h.	24.0	27.6	24.0	25.7
40-60 m.p.h.	7.0	8.1	6.9	8.1
50-70 m.p.h.	9.6	9.7	9.5	9.2
SS ¼-mile	18.2	19.7	18.2	20.0

Urheberrechtlich geschütztes Material

"I'd like to see them make..."

A rolltop lid on car trunks. It would disappear into the back of the rear seat, making it easy to haul bulky, high-standing cargo like a snow blower or a TV set.—*E. Wilczouk, Chicago.*

A four-way guard for flashguns. One could be clear, one diffused, one blue, one perhaps salmon colored, to suit them to different situations and films.—*G. J. Vlahakes, Union, N.J.*



Permanent lubing for lathe centers. A Teflon cap over dead center would revolve with the work, eliminating a revolving center for long turnings.—*Mark Kinsler, Cleveland Heights.*

A built-in hot-spot compartment in the stock of a gun. It would hold a battery- or fuel-type warmer to keep your shooting hand warm in cold weather.—*Ron Busch, Tonica, Ill.*

Cold-barrier foam for spraying over plant beds or over newspaper cones formed around roses and delicate shrubs. In spring, you'd lift it off.—*Linda Gleaves, Muscatine, Iowa.*

Everyone has his own pet idea of a gadget that he would like to see in general use. What's *yours?* We will pay $5 for each one published. Please use Government postcards only. Send to ILTS Editor, Popular Science, 355 Lexington Ave., NYC 10017. Write your name and address clearly. Contributions cannot be acknowledged or returned.

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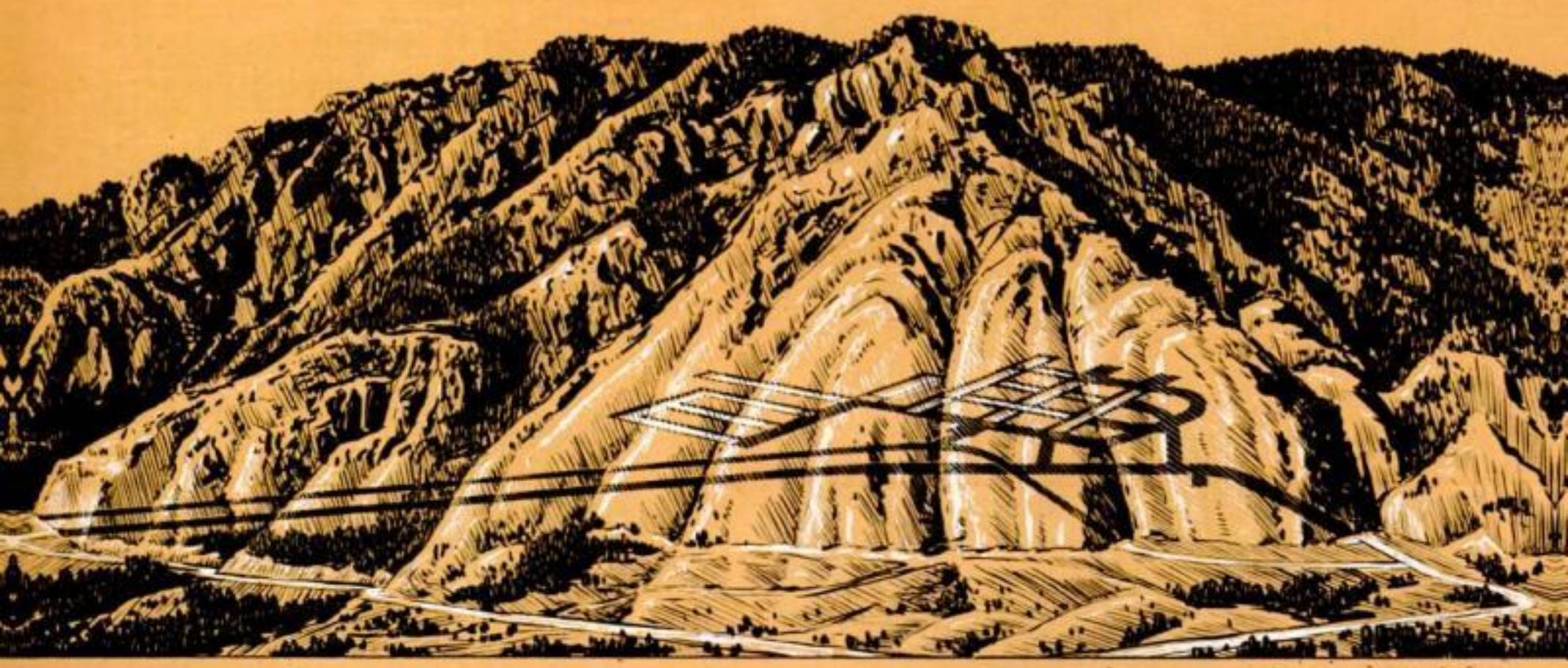
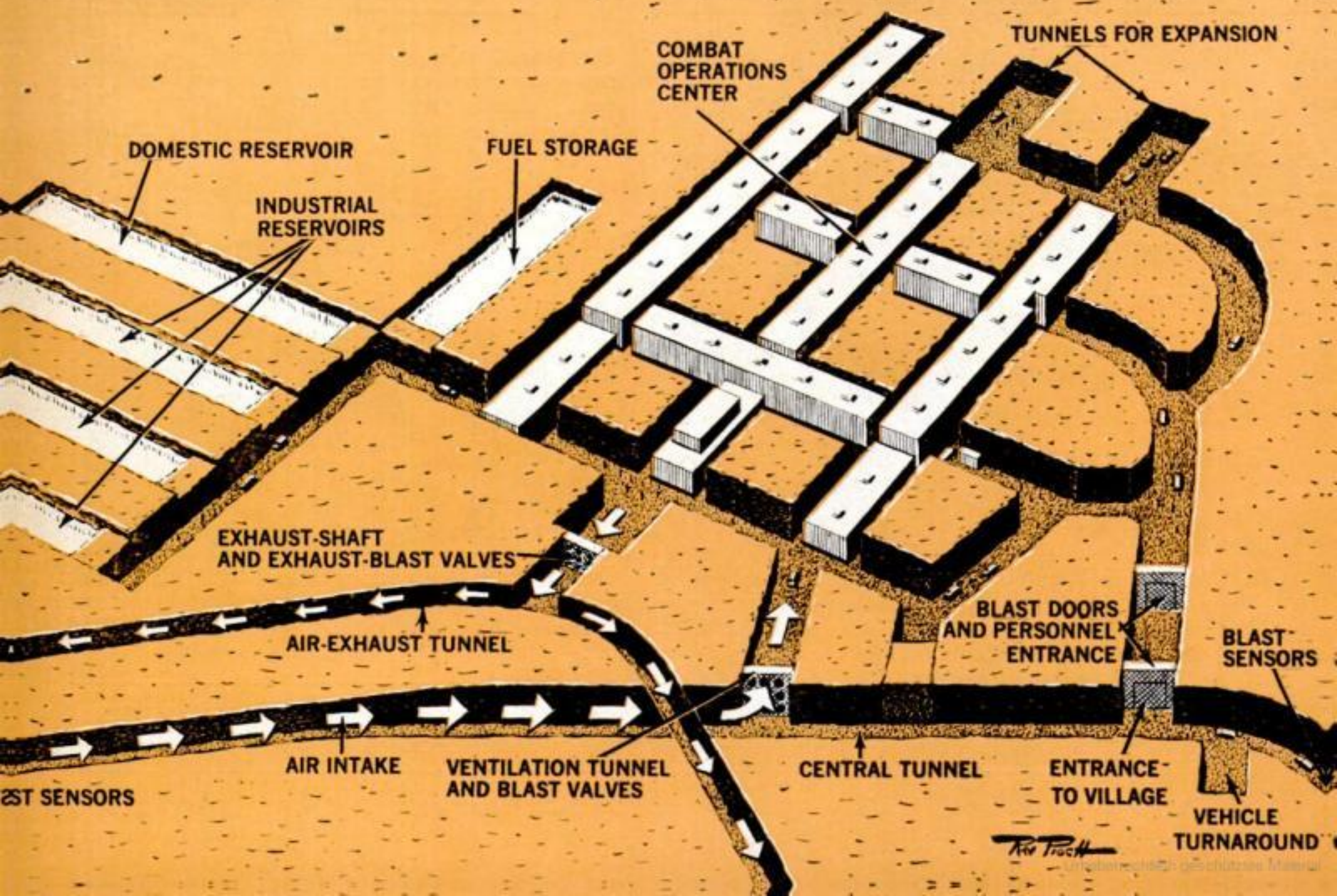
Come Visit the Village

Multi-story buildings on coil springs, nesting in a great pile of granite, house our defense nerve center

By Devon Francis ILLUSTRATED BY RAY PIOCH





Inside a Mountain

IN THE back yard of the city of Colorado Springs, in the Rocky Mountains, is a towering granite eminence named for a zealous U.S. Army lieutenant who discovered it in the year 1806. Zebulon Montgomery Pike isn't even given the courtesy of a possessive apostrophe when "his" peak is mentioned in today's geography books. Quite a hunk of rock, Pikes Peak stands 14,110 feet above sea level, about as high as Switzerland's Matterhorn.

Now, practically on Pikes Peak's toes sits another mountain, named Cheyenne. It's no great shakes as mountains go, though Buffalo Bill, of Wild West fame, is buried at one end of it. Cheyenne Mountain is lumpy. From a distance it looks like a herd of camels under a blanket. It isn't even very high at its apex—a measly 9,565 feet.

But Cheyenne Mountain is the only mountain of its kind in the free world.

It's the only mountain known that has an entire village tucked into its insides. It's the only mountain with a series of buildings all standing on coil springs. It's the only mountain with access tunnels that would close—*snap*—in a twinkling if this continent were ever subjected to attack. Cheyenne Mountain might—just might—be the only place in the world where human beings could survive if every continent were saturated with thermonuclear bombs or radioactive fallout in the ultimate idiocy of unbridled war.

To encompass all this, Cheyenne Mountain must have a special function. It has. It is the nerve center of North America's air-defense system (NORAD). As such, it is probably the world's most elaborate fallout shelter.

In the next month or so the village in Cheyenne Mountain's gullet will be formally dedicated.

Its people will begin a 24-hour vigil against possible attack, with a mountain of granite over their heads.

Cheyenne Mountain's hidden village can accommodate up to 800 persons in a pinch. Normally it will be occupied by three shifts of 200 persons each. They will come and go. Nobody will actually live in the mountain.

The village consists of eleven multi-story buildings. They rest on steel coil springs to ease the shock of a nuclear explosion. Buildings in the complex that house delicate communication and data-processing machines have, in addition, hydraulic shock absorbers to snub down spring rebound. Weight on the springs is carefully distributed so the buildings won't lean.

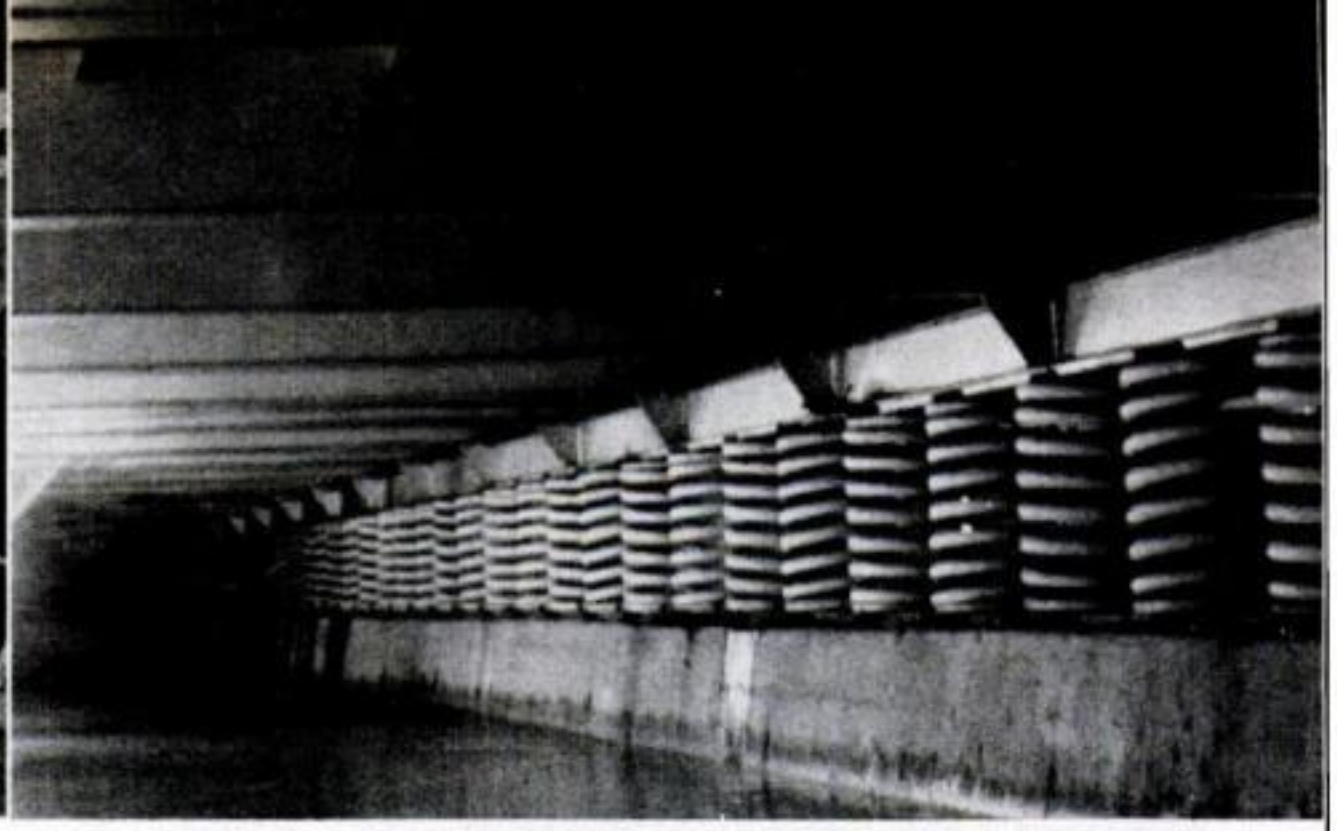
From the inside, NORAD village looks like any other collection of steel-frame buildings—except for the lack of windows. Some of the buildings are three stories high, some only two. The total floor space available is about equal to that in 130 five-room cottages.

As an emergency residence, the village is complete. It can sleep 450 persons at a time and feed twice that number. It has

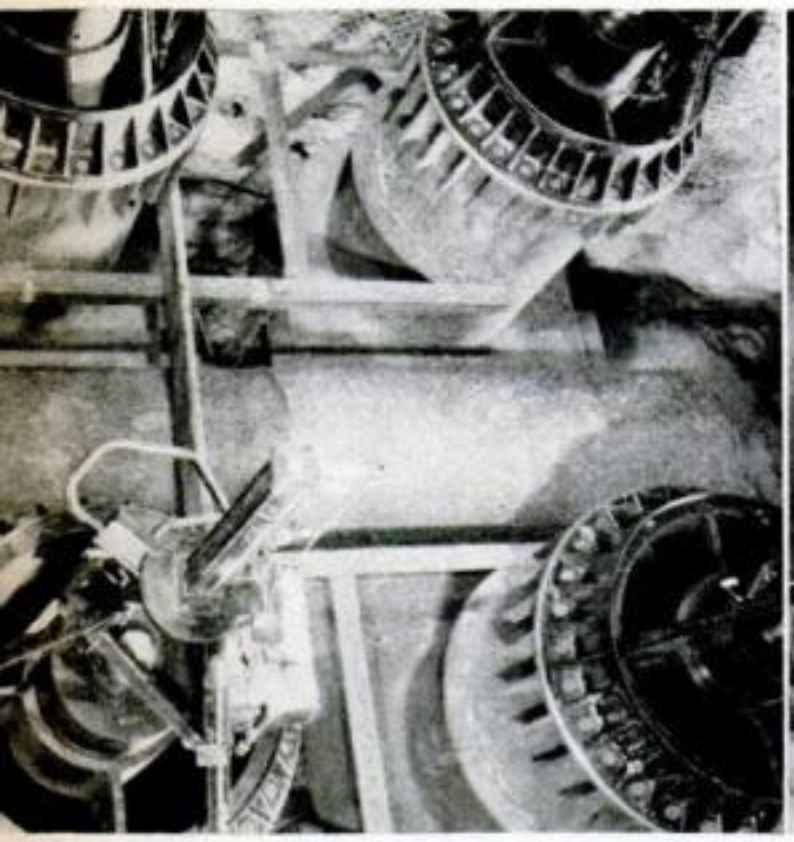
CONTINUED

Cathedral-like arches 60 feet high have been blasted out of interior of Cheyenne Mountain to create joint U.S.-Canadian air-defense center. Truck stands before a building at far right.

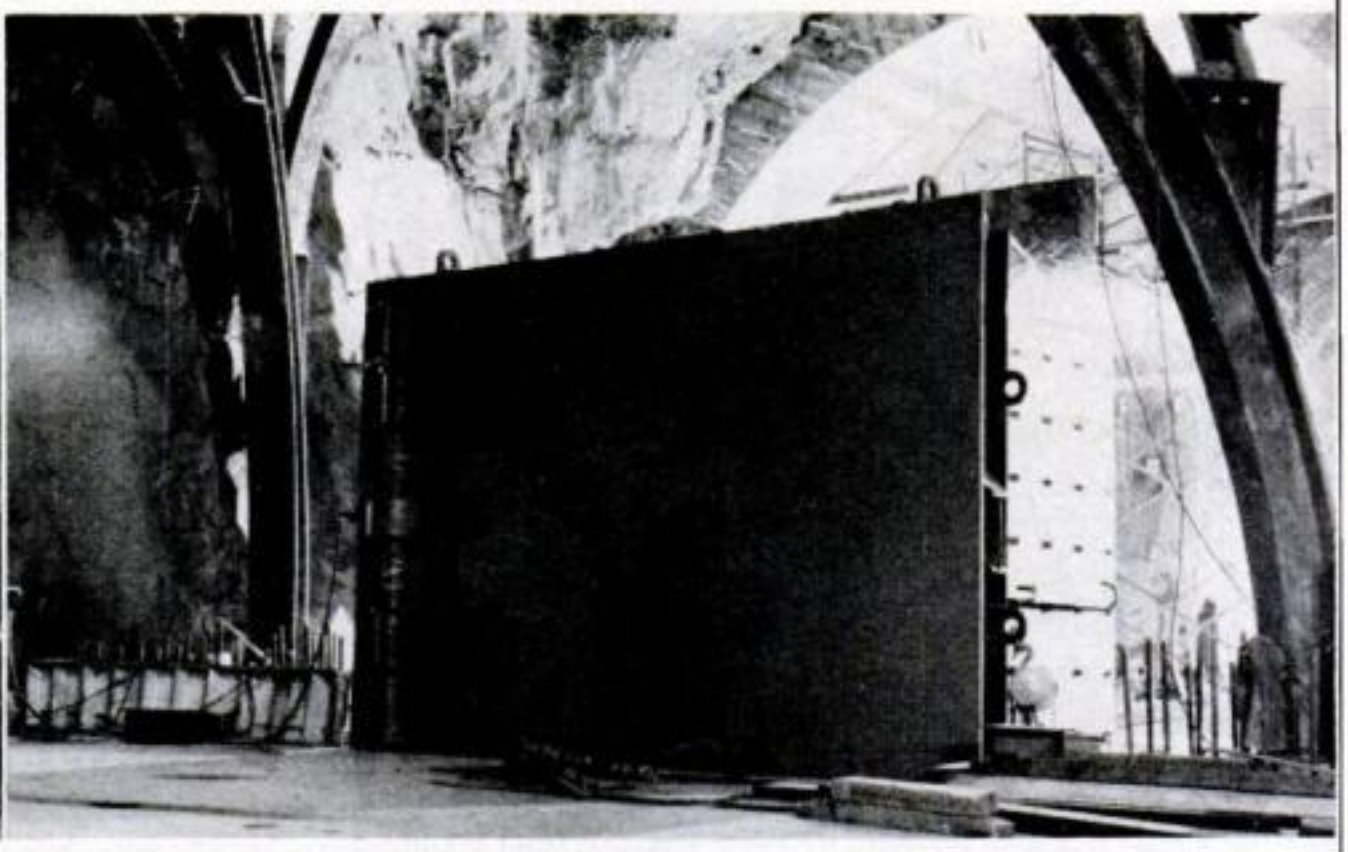
Coil springs—941 of them—made of three-inch wire hold up the buildings. Each spring, 24 inches wide, has a 47-inch free height.



Springs deflect 10-12 inches under load of 14,250 tons of buildings and equipment. A million tons of granite blasted out of mountain was dumped into a canyon at main tunnel portal for a parking lot, reception and security buildings.



Blast valves, patterned after those at Titan II missile sites, sense pressure wave, operate 21 lock or shutoff devices in the system.



Huge blast door, one of two at village entrance, measures 10 by 12 feet and is three feet thick. It will be enclosed in a reinforced concrete wall 17 feet thick. The pictures on these pages were taken by Air Force Sgt. Richard Madara.

water and fuel reservoirs—and, of course. food—to last its inhabitants for weeks if necessary. It has sewage disposal. It has a hospital operating room equipped with everything a surgeon could want, and sick beds. The village weather is perfect 12 months a year.

Nature helped there. The mountain's interior temperature is 58 degrees winter and summer. All that the design engineers had to do was bleed off exhaust gas from a battery of diesel engines (supplying power) for a heat exchanger to make the buildings comfortable, and install an air-cooling system to dissipate heat from rooms housing heat-producing equipment, such as computers. That did take some doing, though—the air conditioners are husky enough to cool an entire city of 35,000. All the larger rooms have individual temperature and humidity controls

While NORAD village superficially looks like any other group of buildings, it had to be designed for survival in all-out war. So each building is completely sheathed in a mighty cocoon of steel plate that is sealed tight. The tiniest pinhole is welded shut. That's to protect the electronic equipment from the "electromagnetic pulse," an electrical shock wave of almost incalculable size that is one of the products of a nuclear explosion. Each building is, of course,

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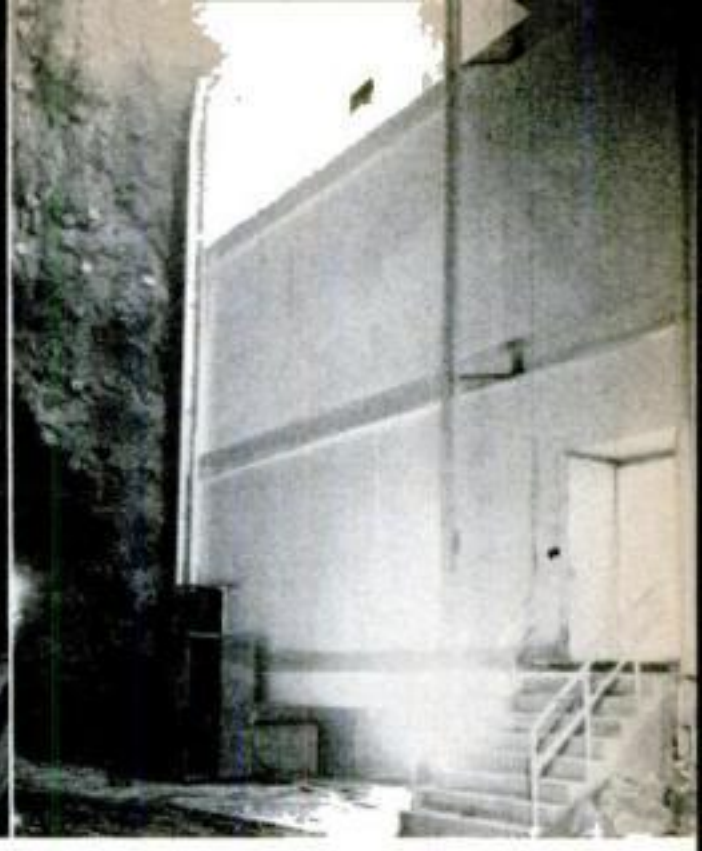
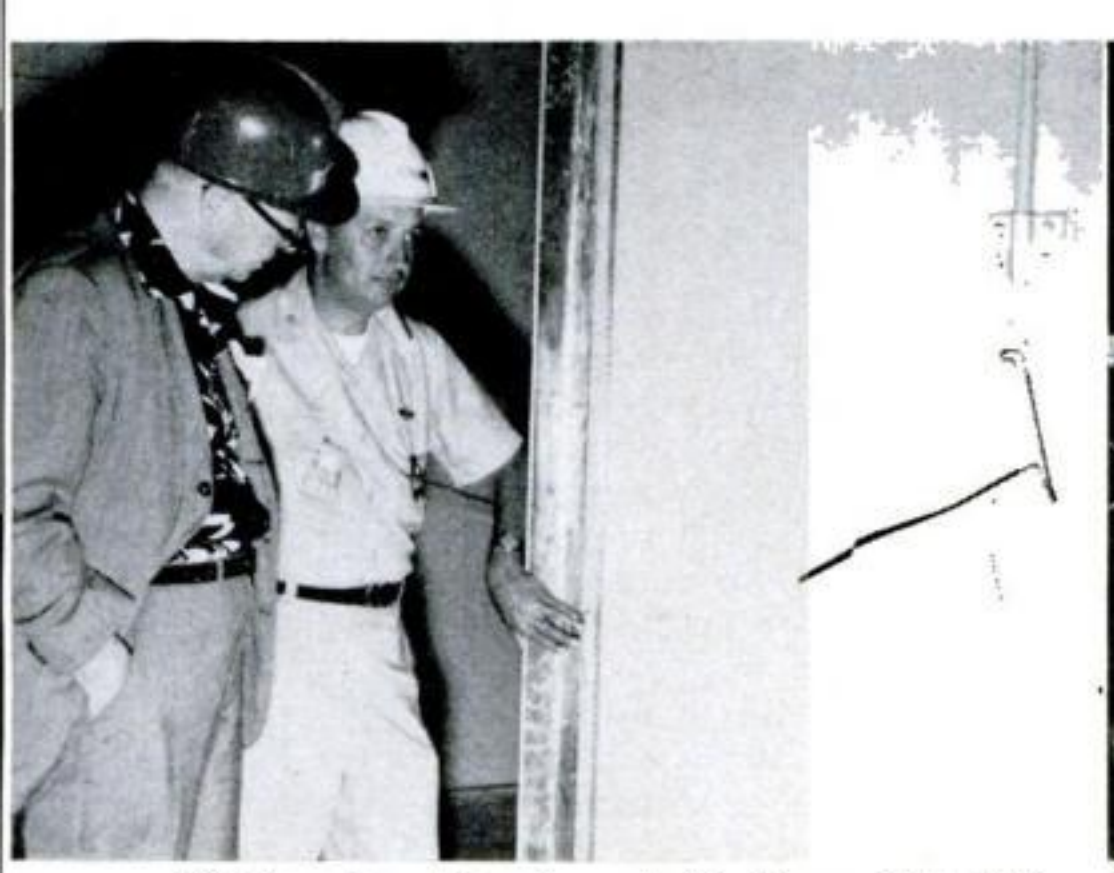
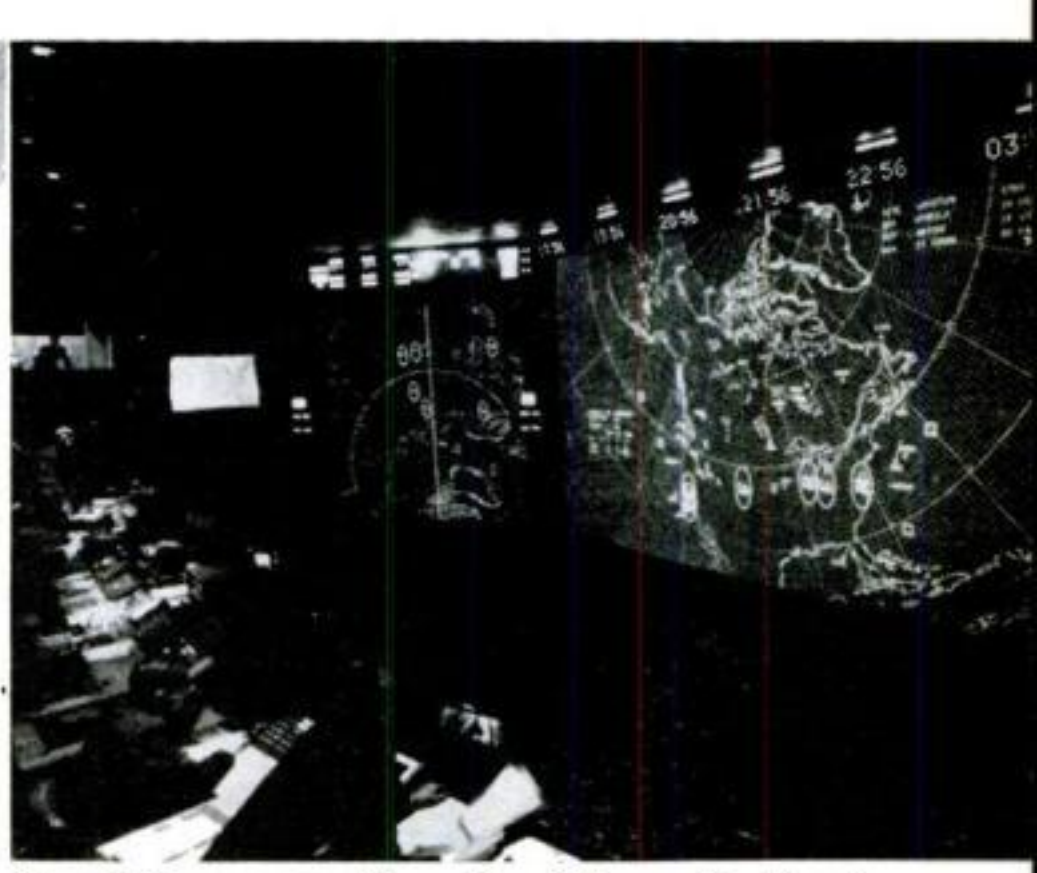
Typical three-story building in NORAD village, shown here under construction, provides part of the 170,000 square feet of floor space. There are 11 buildings, ranging from 29 to 42 feet wide, 98 to 320 feet long, and 14 to 42 feet high.



Completed building has solid steel walls, is raised for footings. spring supports. Village has three miles of tunnels.



PS Reporter Francis and Air Force Col. Dellenger (wearing hard hats because work was still in progress) examine a door that is copper-sheathed against "electromagnetic pulse."



Two big screens picture the defense situation for NORAD. There is direct communication with Strategic Air Command and military headquarters in Washington and Ottawa.

grounded, and grounding cables tie all the buildings together.

The doors to all buildings are copper-edged with a sort of electrical weatherstrip for the same reason. The doors are double, with walkways between, and solenoid interlocks prevent both being opened at the same time.

The entrance to NORAD village is by way of a tunnel a quarter of a mile long. It was blasted through the granite on the mountainside at the 7,000-foot level. Two great steel doors, standing in tandem 50 feet apart and weighing 43 tons each, bar the way to the village proper. Another interlock prevents opening both simultaneously.

These are the village "blast doors," designed to withstand all but a direct hit by a nuclear bomb. So securely sealed will they be when complete that a person caught between them could, in time, die for lack of air.

All access openings in the village complex inside the mountain, for incoming and exhaust air, water, and sewage, are linked electrically to air-pressure sensors on the mountain's skin. A pressure wave from an explosion would cause the sensors to telegraph a message that would automatically snap shut valves on the access openings. If the sensors should fail, the pressure wave

[*Continued on page 192*]

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Finding Out How to Land on

Joe Walker, chief pilot at NASA Flight Research Center, has made 75 percent of test flights.

"SOUNDS like a private war," says Joseph A. Walker as he describes a hop in this remarkable flying machine.

Walker, chief pilot at NASA's Flight Research Center, Edwards Air Force Base, Calif., was talking about the LLRV, a Lunar Landing Research Vehicle.

A mechanical spider 21½ feet long, 13½ feet wide, and 10 feet high, it really makes a racket. Screaming wails from its jet and explosive bursts from hydrogen-peroxide rockets are not easy on the ears.

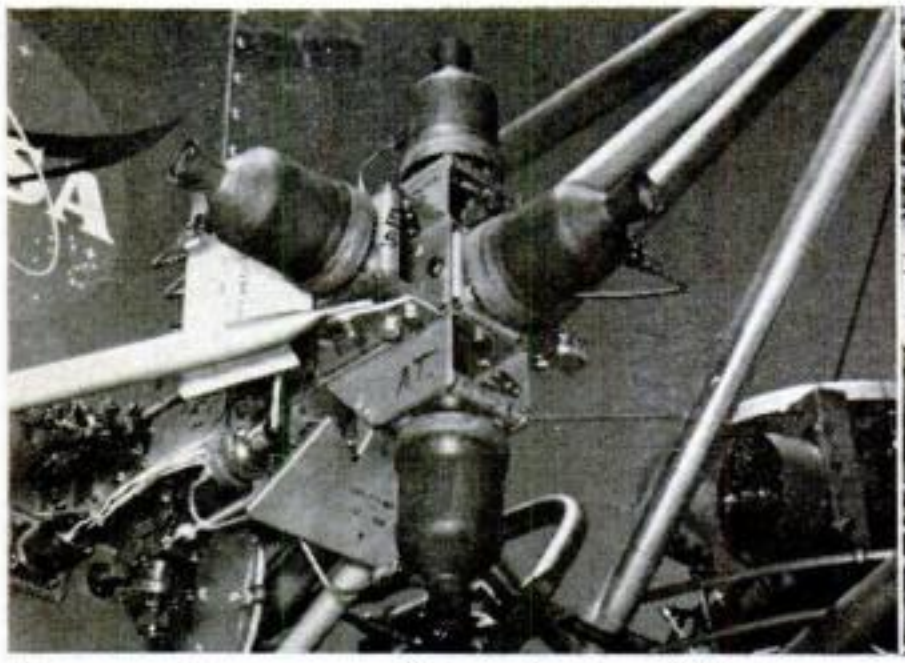
A typical flight—Joe calls it levitation—consists of shooting straight up 100 to 800 feet, hovering a few seconds, then swooping down at half the climbing speed and landing on or close to a predetermined spot on the runway. Elapsed time: about five minutes.

What's the point? It's to simulate the final 1,000 feet of an astronaut's eventual approach to the moon. Two astronauts some day will be landing from an orbiting Apollo command module in a buglike LEM (for Lunar Excursion Module). Maybe they'll land where they at first intended, maybe go on for a mile or more while they search out a better site.

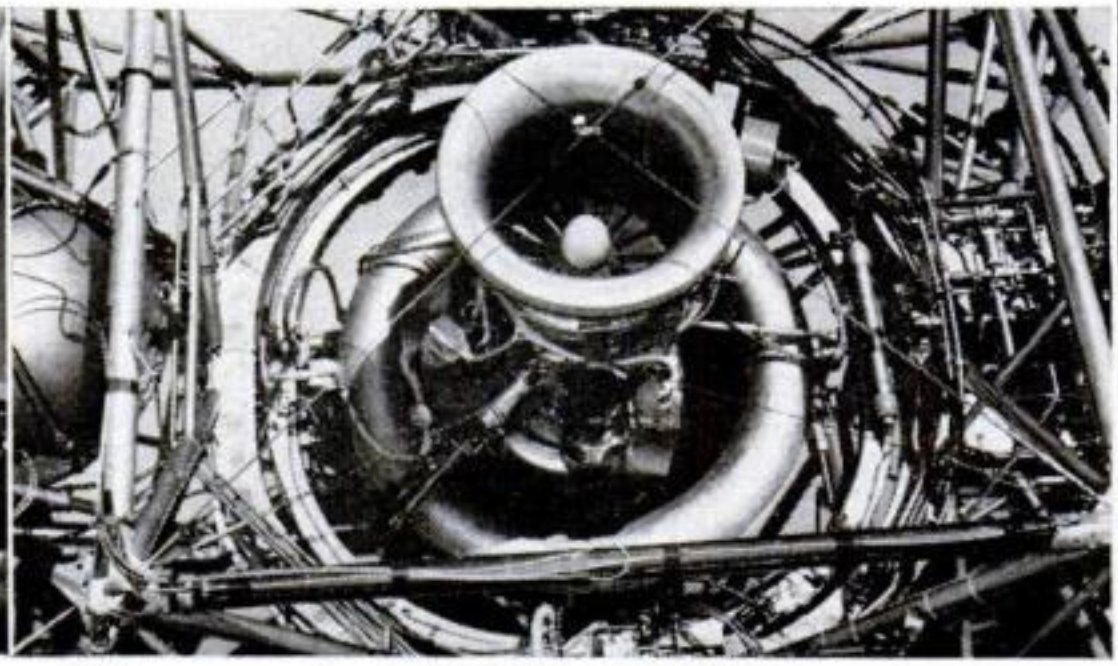
The LLRV works out control problems in advance. The LEM itself would crash if maneuvered as violently near earth as it may have to be at the moon, where gravity is one sixth as strong. Bell Aerosystems and NASA worked out the LLRV as a substitute for research and pilot training. It can tilt 30 degrees in safety, its gimbaled jet engine at the center always pointing straight down.

With engine throttled to sustain five-sixths of its 3,700-pound takeoff weight, it simulates moon weight. Its lift rockets provide boost comparable to the LEM's retro rockets, and its attitude-control rockets perform on a scale close to those that control LEM pitch, roll, and yaw.

The LLRV schedule calls for 150 to 170 lunar-landing simulations through next August. Apollo astronauts will check out on it at Edwards; then it and another like it will go to the Manned Flight Center at Houston to train the men who will make actual touchdown on the moon.



Close-up shows one of four clusters of hydrogen-peroxide attitude-control rockets at each corner of Lunar Landing Vehicle. They provide fixed thrust ranging from 18 to 90 pounds. The settings are established before each flight and cannot be altered once craft is off ground.



Main power plant of LLRV is CF-700 jet engine with fan behind it. It produces 4,400-pound thrust at sea level if temperature isn't too hot. For simulating lunar landings, engine is throttled back to sustain only five-sixths of craft's weight. Rockets support remainder of its weight.

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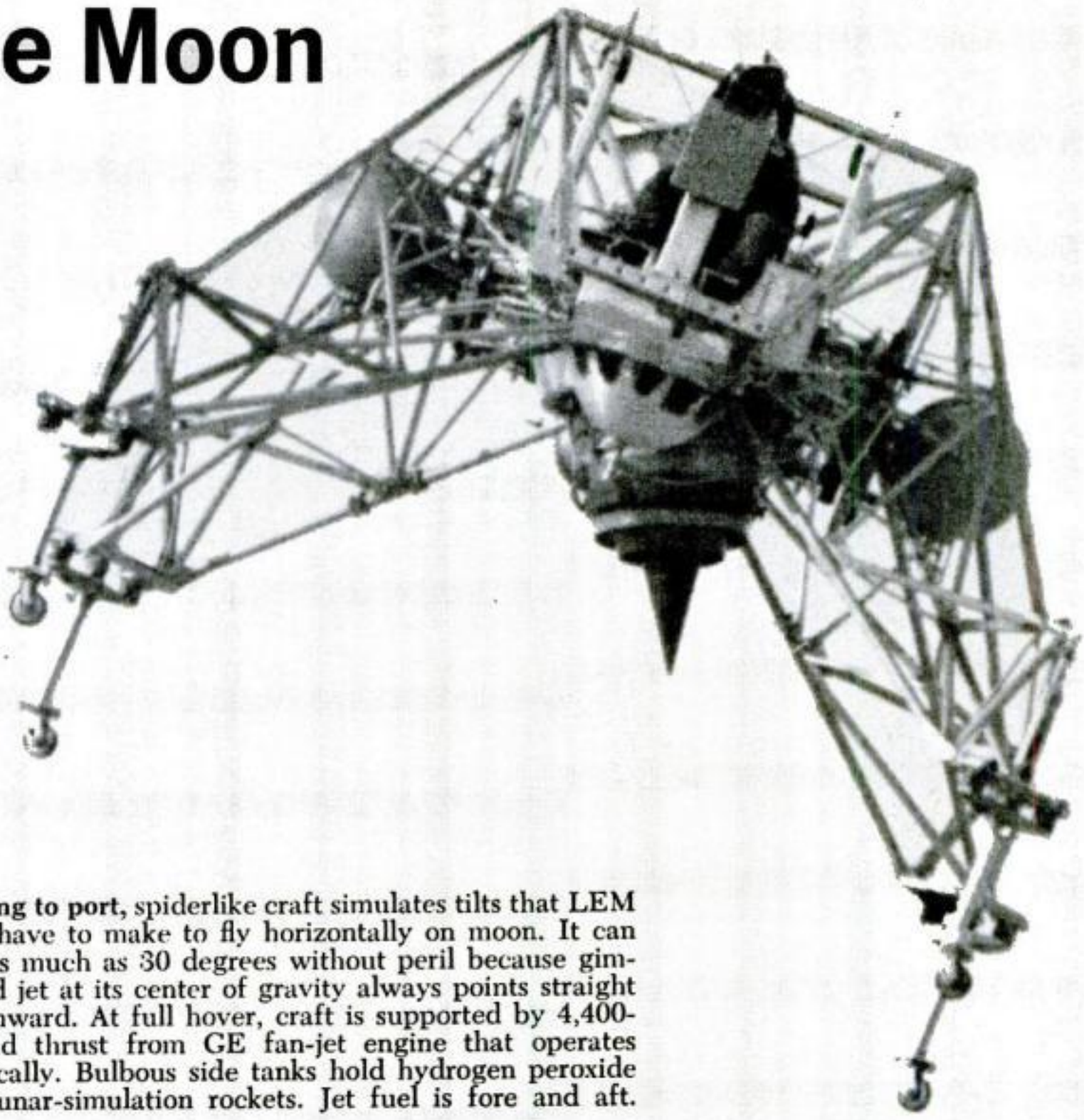
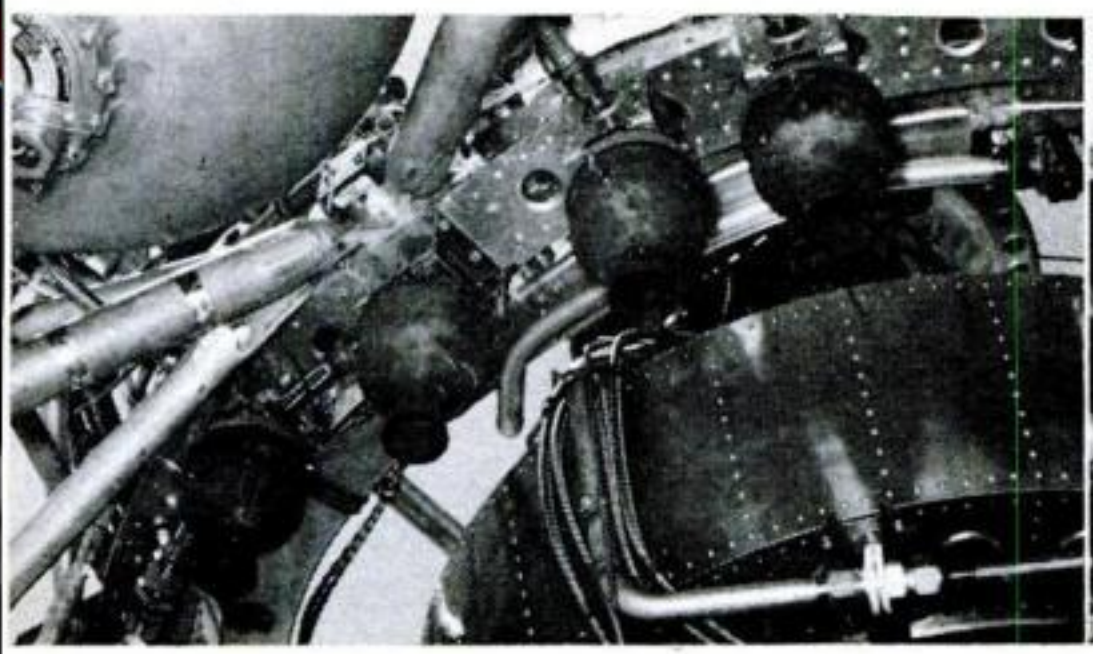
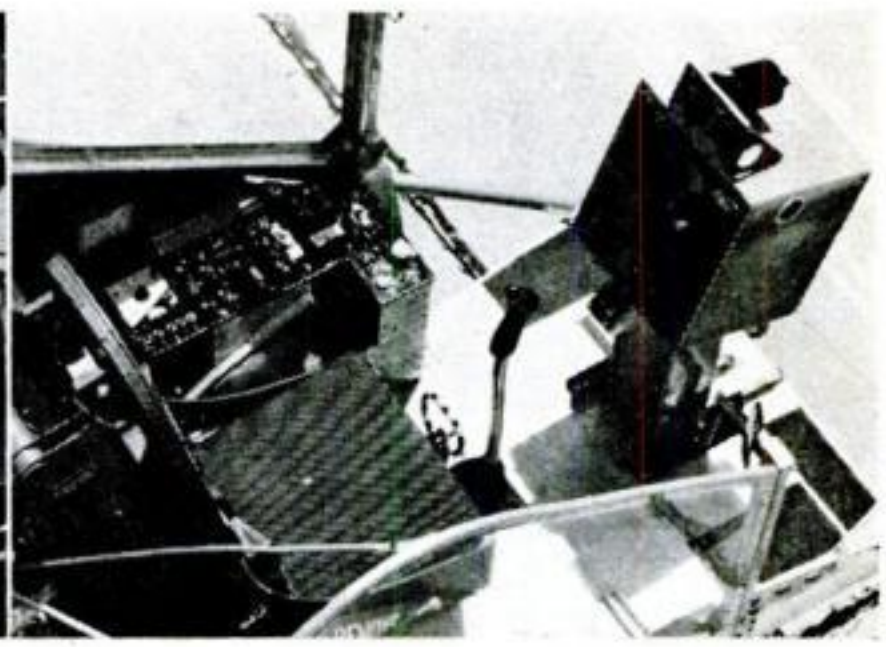
the Moon



Listing to port, spiderlike craft simulates tilts that LEM will have to make to fly horizontally on moon. It can tilt as much as 30 degrees without peril because gimbaled jet at its center of gravity always points straight downward. At full hover, craft is supported by 4,400-pound thrust from GE fan-jet engine that operates vertically. Bulbous side tanks hold hydrogen peroxide for lunar-simulation rockets. Jet fuel is fore and aft.



Four big hydrogen-peroxide lift rockets are on each side of main engine. They fire in opposing pairs to keep from turning vehicle over and provide variable range of 200 to 1,000 pounds' thrust per pair. Only one pair is used, but if main engine fails, all four can support craft.



LLRV's open cockpit is much like helicopter's, and Joe Walker and other NASA pilots in program got extensive helicopter training before taking up LLRV the first time. Controls are now undergoing modification to duplicate side-arm controls that will operate LEM on the moon.

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They're Solving the

How did the universe begin? Will it come to an end? Faint stars seen through giant telescopes and the weak whisper of mysterious radio signals seem to hold the answer

World's Greatest Mystery

By C. P. Gilmore

THEY find the clues in weird places, in weird ways. In a dome-shaped building perched on a low mountain not far from Los Angeles, an investigator climbs into a complex framework of moving beams and girders to take a photograph. Later, the developed plates show nothing but a few fuzzy lines. But they tell an incredible story.

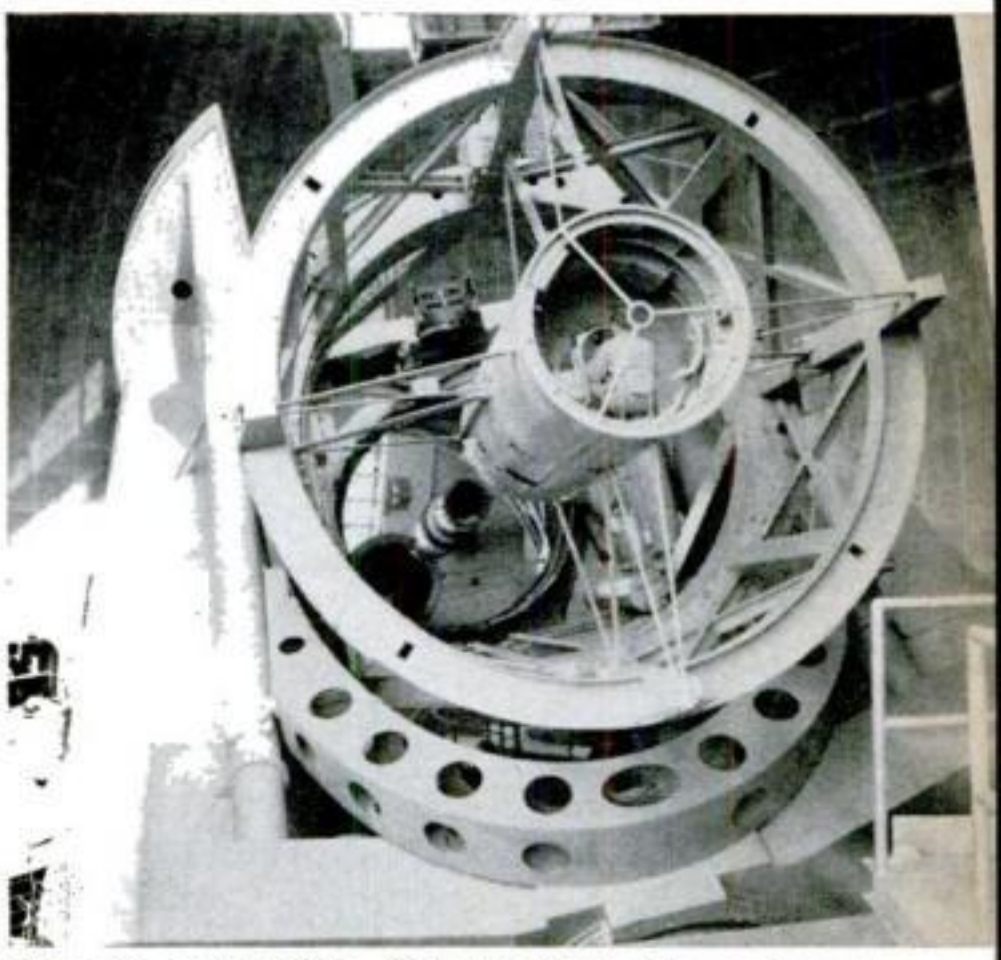
On a New Jersey hilltop, another scientific sleuth tries to track down a strange noise he keeps hearing. He fails—but still uncovers valuable information.

In a desolate area near Parkes, Australia, a 210-foot steel bowl swings across the night sky. Inside a nearby building, an operator feeds the faint hissing, crackling sounds scooped up by the bowl to a computer. The machine, in turn, spews out long columns of figures.

All over the world, hundreds of investigators like these are working to solve the world's biggest mystery. They're out to answer the Big Question: Where did it all come from? When did the universe begin, and how? Or did it have a beginning?

The shadowy outlines of the solution are already beginning to appear; the bits and pieces collected by scientific detectives over the years are beginning to fit together. And fresh new information is cascading in. On California's Mount Palomar, the world's biggest telescope is uncovering vital clues almost daily. The fledgling field of radio astronomy has opened wide new windows on the universe. "It's an exciting time to be an astronomer," says Dr. Arno Penzias, who has played a key role in recent discoveries.

Collecting the clues. For almost a century, astronomers have had two principal ways of studying a star. The first is simply to look at it or photograph it through a telescope. The second is to beam the star's image through a prism or diffraction grating, spreading the starlight out into a thin line. Such spectrographic lines are dotted with dark areas. Each dark spot or line is caused by atoms in the star's atmosphere that absorb light at some particular location in the line. By studying the absorption lines, scientists can tell which atoms caused them; hence, what elements are in the star's atmosphere.



Quasars and BSOs, "stars" that date universe, reveal size, were found at Mt. Palomar. Observer (above) sits at focus of 200-inch telescope.

The spectrographic lines are handy in another way, too. In 1888, a German astronomer, H. C. Vogel, discovered that while some star spectrograms were normal, others were strange looking. Certain lines, those from oxygen and calcium, for example, would show up out of place—too far toward the red end of the spectrum.

The most obvious explanation for the shift seemed to be the Doppler effect—the

CONTINUED

◀ **Radio noise that Dr. Penzias (in horn antenna) heard was the bang that began universe.**

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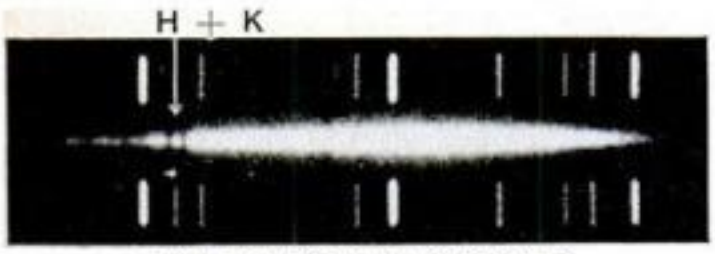
Star spectrograms show speeds, distances. Observer is at 200-inch telescope with spectrographic equipment.



750 MILES PER SECOND

9,300 MILES PER SECOND

24,400 MILES PER SECOND

38,000 MILES PER SECOND

Spectral lines of distant galaxies shift to the red (lower) end of spectrum, indicating Doppler effect. In these photos, vertical lines are constant reference marks; horizontal bands, spectrograms. Dark lines near arrowheads are H and K calcium lines. The increasing shift of these H and K calcium lines for each of four different galaxies can be translated into increasing speeds.

Dr. Penzias (left) and associate remove wave guide at end of horn antenna that picked up mysterious noise.

A picture of our universe is emerging from

same physical principle that makes a train whistle sound higher pitched when it's coming toward you, lower as it goes away. If the spectral lines from certain stars were shifted toward the red—or lower—end of the spectrum, Vogel reasoned, then the stars, and the galaxies made from them, must be moving away from the earth. And the distance the lines were displaced—the amount of the red shift—would give an accurate measure of speed.

In the late 1920s a young astronomer, Edwin Hubble of California's Mount Wilson Observatory, found that the amount of the red shift of any object was directly proportional to its distance. And this led to one of the landmark discoveries in the history of science: Galaxies all over the universe are flying away from the earth. And the greater the distance, the faster they are moving.

The cosmic egg. A Belgian mathematician, Abbé Georges Lemaître, took the process one step further. Some time in the remote past, he said, all matter in the universe was part of a great "cosmic egg." The egg exploded and sent matter flying in all directions. Today, that matter—including our galaxy—is still flying apart, like the debris of a gigantic explosion. By noting the positions of certain galaxies and their speeds, Lemaître calculated that the cosmic catastrophe had occurred 1.8 billion years ago.

There was one major flaw in Lemaître's "big-bang" theory: While his figures gave the age of the universe at 1.8 billion years, radioactive measurements of the earth indicated that our planet was twice that age—maybe more. Astronomers began to look for an explanation.

The first to gain wide attention was developed by a brash, tousle-headed, cocky young British mathematician named Fred Hoyle. Hoyle began designing his cosmological picture in 1937, when he was a 22-year-old mathematics instructor at Cambridge. During the war, while involved in radar design, he worked on cosmology on the side—"like a schoolboy reading comics under his desk instead of doing his arithmetic," as one colleague put it. By 1948, Hoyle and several co-workers were ready to spring the new scheme on a waiting world.

The universe can contain a five-billion-year-old planet, said Hoyle, because the universe is eternal. It had no beginning, and it will have no end. It's always the same.

Why are the galaxies flying away from each other? Because, said Hoyle, hydrogen atoms are continuously being created in space. The hydrogen eventually coalesces into new galaxies to make up for those disappearing at the edge of the universe. The whole process is like a running-over bathtub; keep pouring in water, and some runs over the side. But the amount in the tub is always the same.

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tiny bits of cosmic data

Where did the new material come from? Hoyle didn't know. But then, he said, nobody knows where the material in the big-bang universe comes from, either. And it's no stranger to think that the universe is created in space one atom at a time than that it all started with a big bang at one particular time.

Some scientists had a hard time swallowing what soon came to be called the steady-state theory of continuous creation. But nobody could prove it wasn't so. And Hoyle's mathematics was as good as the big-bang figures.

An oscillating universe? Some big-bangers, meanwhile, had figured out a way to avoid the sudden, spontaneous creation of matter in their theory. The universe and all matter in it has always existed, they said, and there wasn't simply one big bang, but a series of them. After each explosion, the universe would be thrown outward. Eventually, it would slow down, fall back in together, and explode again. This variation of the big bang came to be called the oscillating theory of the universe.

By the early 1950s, astronomers had figured out a way to tell which of the three models—the steady state, the big bang, or the oscillating—was right. Just gaze up into the night sky and see how the galaxies are distributed at great distance. If you looked out far enough—say five billion light-years—you would also be looking back in time, since it would have taken five billion years for the light of the galaxy to reach the earth.

Now if the galaxies were closer together five billion years ago than they are today, this would support the big-bang theory. On the other hand, if the distribution was about as it is now, the steady-staters were right. Then measure the speed of the distant galaxies. If they were moving faster than the galaxies are moving today, this would indicate expansion of the universe is now slowing down. Ultimately it will stop and fall back in. That would mean the oscillators were right.

There was just one catch. No telescope could see far enough. The giant 200-inch telescope that had just gone into operation in 1949 on Mount Palomar would, it was calculated, have a range of just about a billion light-years. The only hope, apparently, lay in the huge radio telescopes then being constructed. Some of them might have enough range.

A double-size cosmos. Meanwhile, the Palomar eye took its first look at the sky. Almost at once, scientists made a major discovery. The cosmic yardstick, the technique used to measure astronomical distances since the early years of the century, was found to be off—by exactly 100 percent. At a single stroke, the universe was shown to be exactly twice as big as anyone had thought. And the big eye on

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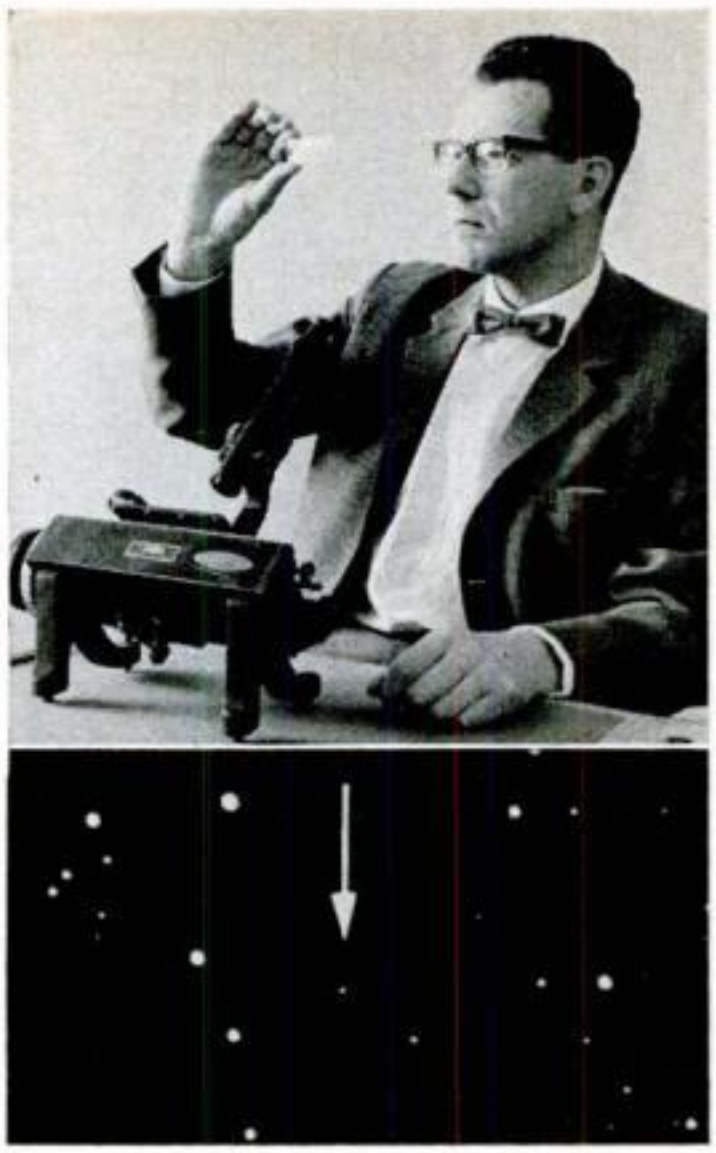
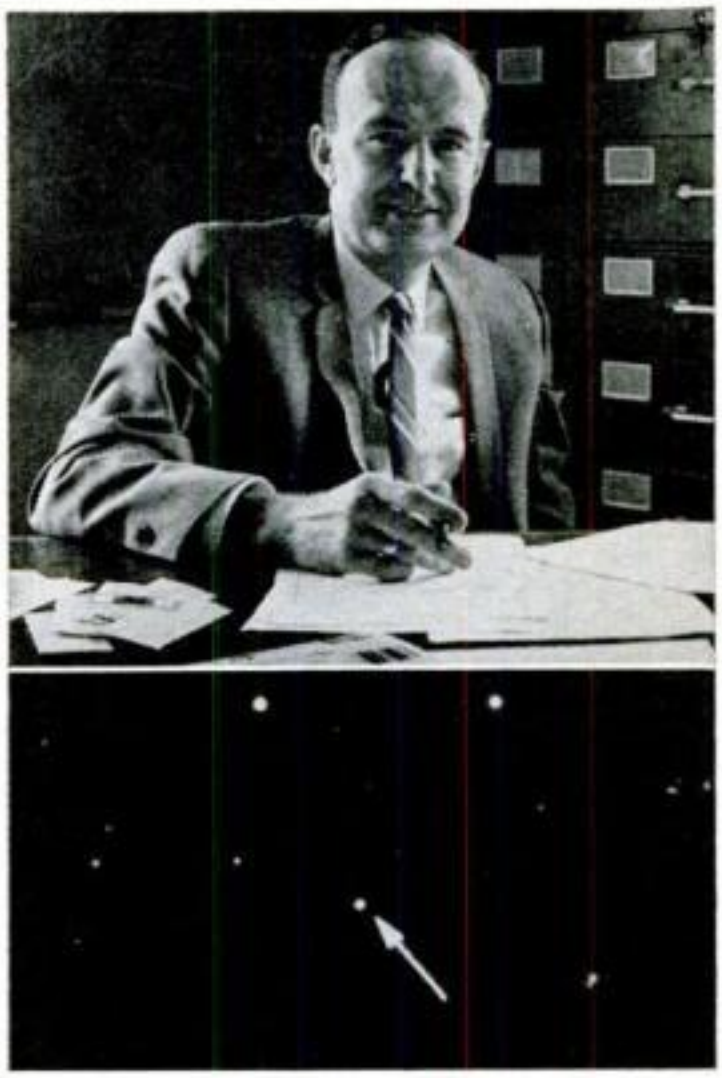


The small white dot, pointed out by arrow, is a quasar, 3C-9, the most distant known object in the universe. The light that made the dot left 3C-9 many billions of years ago. Above, Dr. Maarten Schmidt, one of the discoverers of quasars, examines 3C-9 spectrogram.



Dr. Allan Sandage discovered quasi-stellar blue galaxies (BSOs), which radiate huge amounts of ultraviolet like quasars, but no radio waves. There are so many BSOs reaching so far into space that they should provide much vital data. Arrow points out BSO 1.

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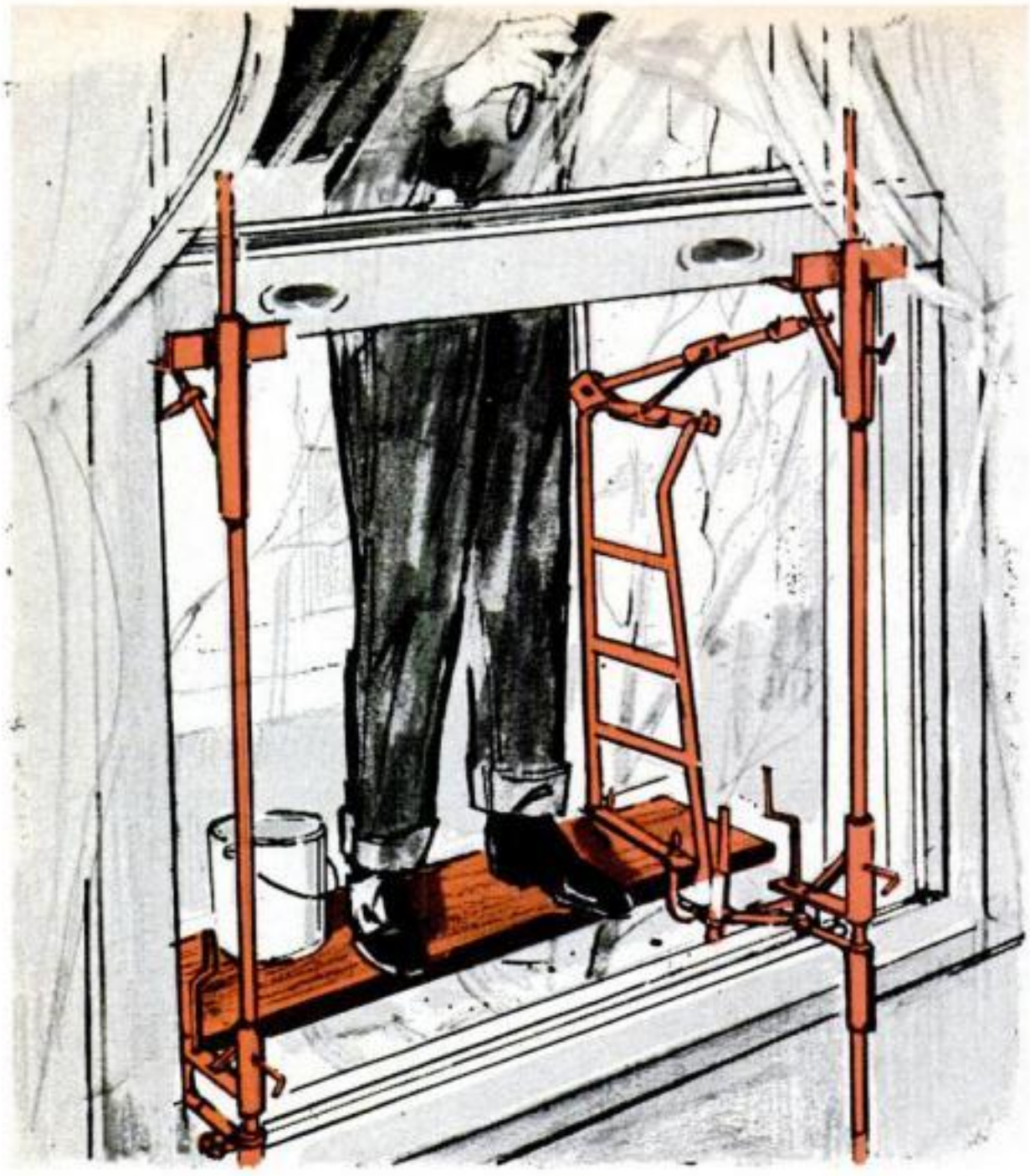

New Ideas from the Inventors

Scaffold sets up from inside. Painting and maintenance jobs might be done more safely and easily on this recently patented scaffold. It would be set up from inside a window and locked to the frame by adjustable clamps. Platforms could be inserted at different heights in the side pieces. Two units secured in adjoining windows could support a large wall scaffold for work between windows.

Thermostat closes fireplace damper. This small, heat-responsive damper inside the regular one would let a fire burn itself out without smoking up a room, then seal off the flue to save room heat. A thermostatic coil would open and close the inset damper, so you wouldn't have to douse a fire or wait up for the embers to die away.

Rod shows low tire. You could tell at a glance when a tire needed air if you installed an indicator like this in a second valve opening in the rim. When pressure was normal, a colored rod would fill a projecting transparent tube; if pressure fell, a diaphragm in a tiny chamber inside the tire would retract the indicator rod.

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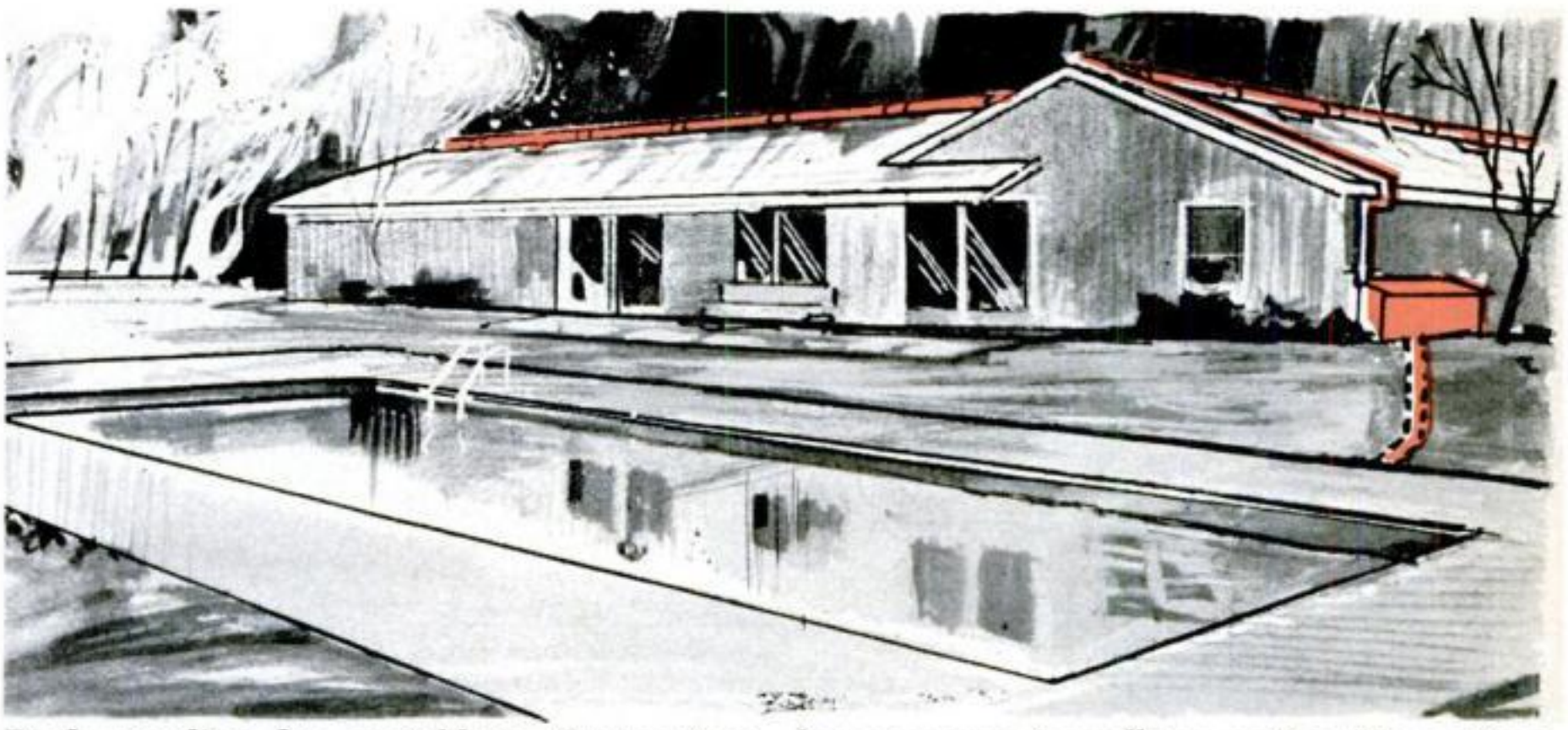
Trough catches cigarette ash. Slipped over a cigarette, this one-use aluminum-foil sleeve would hold ashes until you had a chance to flick them, catch sparks or live ashes, form a stand for a lighted cigarette, or snuff a forgotten one. The inventor says the metal sleeve would also slow the burning of tobacco and cool the smoke.

Dispenser retrieves market carts. Shopping carts might be returned more promptly and in better order at a market that installed a dispenser like this. When a key on the cart passed through a slot, the dispenser would release trading stamps or some other small prize. Nested carts would return to the store riding down a sloped track.



Pool supplies fire sprinklers. Connecting a sprinkler system to a back-yard swimming pool might provide insurance against dry-season fire hazards that arise because of low pressure in wells or mains. Connecting the pool to a pump supplying automatic rooftop sprinklers would give protection against falling sparks from brush fires.

The following patents have been issued on these inventions: **Scaffold**—*No. 3,135,351 to C. Economos and G. Vaillancourt, New Bedford, Mass.;* **Damper**—*No. 3,134,377 to H. Kanoy, Salisbury, N.C.;* **Tire Indicator**—*No. 3,129,689 to H. Henderson and P. Heath, El Segundo, Calif.;* **Ashtray**—*No. 3,165,105 to R. Campbell, Oak Park, Ill.;* **Cart gate**—*No. 3,165,189 to K. Easterday, Orange, Calif.;* **Sprinkler**—*No. 3,179,181 to C. Banzato, Beverly Hills, Calif.*

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington, D.C. 20231, at 50 cents each. To write to an inventor, if the address above is insufficient, address him (by name and patent number) in care of the Commissioner of Patents.

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How We Track Our Spacecraft

At periscope in blockhouse, author views Cape launching.

With telescopes, cameras, and radar, the Eastern Test Range's far-flung outposts speed amazingly detailed news of where a "bird" is heading and how it's doing

By Dr. Wernher von Braun

Director of NASA's George C. Marshall Space Flight Center, Huntsville, Ala.

A FEW minutes after a group of spectators see a space vehicle blast off from its launch pad at Cape Kennedy, Fla., the public-address system announces that the spacecraft has been successfully injected into an orbit with a period of revolution of 88.6 minutes, a perigee altitude of 99.6 nautical miles, an apogee altitude of 122 nautical miles, and an orbital plane inclined by 31.73 degrees to the plane of the equator.

A few hours later, this announcement is followed by the most detailed information on stage separation, angle-of-attack encountered in flight through layers of high wind speeds, irregularities in tank pressurization or control voltages, turbopump speeds, structural vibrations, deployment of spacecraft antennas, and many other items of interest.

The tracking and data-acquisition system serving "ETR," the Eastern Test Range, makes this miracle possible. It is probably even more complex than the space vehicle whose performance was just announced. It employs optical, radar, and radio gear to look at, and listen to, the rapidly escaping bird. It involves stations on the American continent, on downrange islands, in aircraft, and aboard ships. It provides radio and cable communication links between all these stations. And it includes a set of timing signals to put all stations on a standard "time base," which is absolutely essential for meaningful data reduction.

The Eastern Test Range is served by 12 tracking stations. Range Station No. 1, by far the most elaborate, is located at and near Cape Kennedy proper. It is equipped with about everything that has ever been invented and used in this field.

Optical equipment. A particularly important part at the Cape is played by optical equipment because, contrary to the situation at downrange stations, the bird is relatively near. Optical coverage of a launch includes:

- An array of documentary cameras. Their films and still pictures not only serve for formal reporting and public information, but also have played a vital role in analyzing causes of mishaps before or shortly after launch.
- Ballistic cameras, such as the Wild BC-4—an extremely precise still camera using a large, optically flat photographic plate. Several such cameras look at the bird's expected track of ascent from different vantage points. Their shutters are repeatedly opened and closed, simultaneously, by signals from the standard range timing circuit. On each plate the bright trail of a rising rocket appears as a string of beads, whose spacing grows as the rocket gathers speed. By placing the plates in a specially designed

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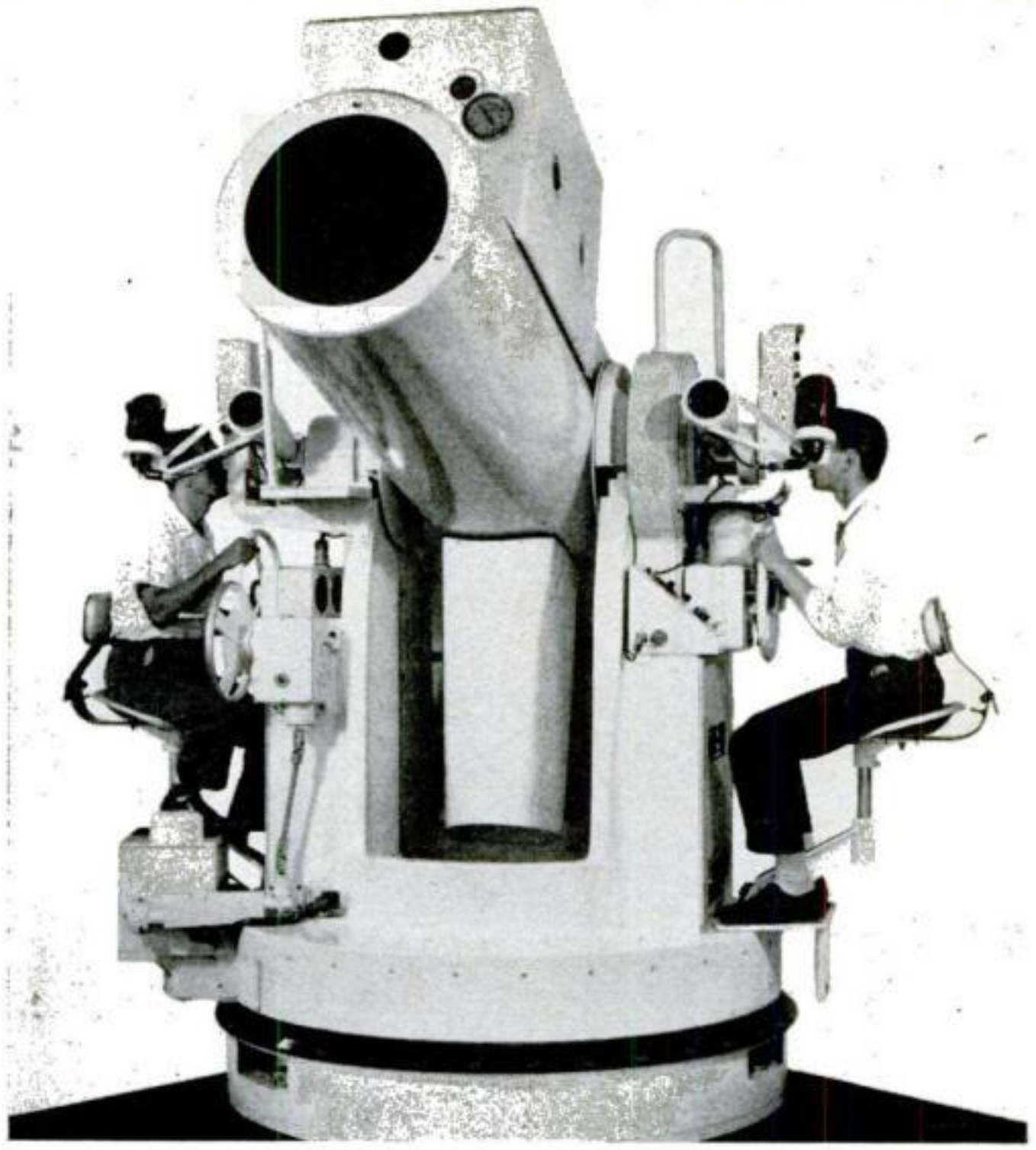
Tracking ships like the Gen. Hoyt S. Vandenberg, seen in Air Force photo, supplement the mainland and island stations of the Eastern Test Range.

Two men at hand wheels operate "Igor" tracking telescope (right) to make long-range photos of the behavior of an ascending rocket vehicle.



Sample photo made with far-seeing "Igor" telescope pictures a striking scientific experiment at 65-mile altitude—a cloud of ice crystals formed when a mighty Saturn I rocket loosed 95 tons of water into the upper atmosphere.

viewing machine, which works on the stereo principle, it is possible to reconstruct the trajectory with very high precision. Ballistic cameras, incidentally, are used at the down-range island stations also.

● Cine-theodolites, such as the Askania Kth 53, a film camera operated by two men simultaneously. One mans the azimuth wheel; the other handles elevation. Both try to keep the bird in the cross hairs of their fields of view. Each film frame photographs the pointing direction of the camera (as indicated on the setting circles in azimuth and elevation) as well as the bird. This makes it easy to compensate for inaccurate alignment and jitter. By placing one frame of the film at a time in a compensator, which permits shifting the image of the rocket back to the picture's center, azimuth and elevation angles are corrected.

● Tracking telescopes, such as the American Optical Company's Igor (Intercept Ground Optical Recorder), pictured in the photograph above. In essence this is a very powerful telescope on a mount somewhat

[*Continued on page 197*]

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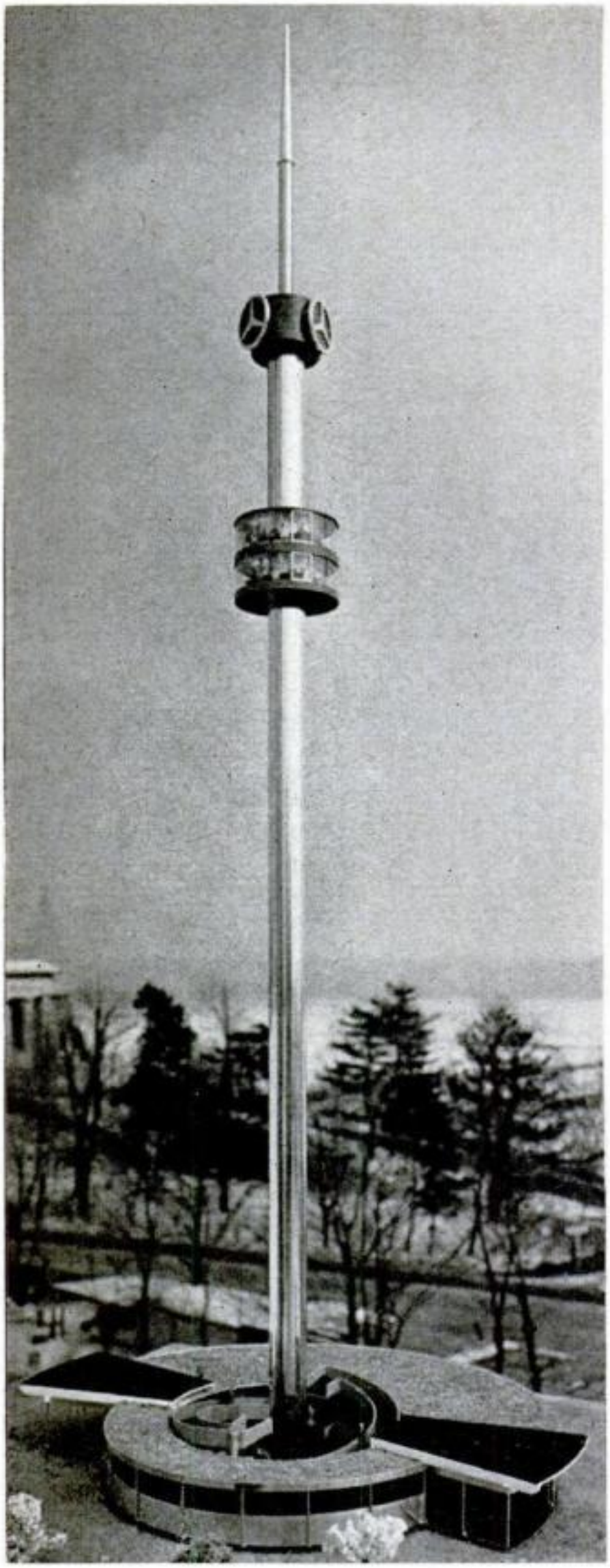
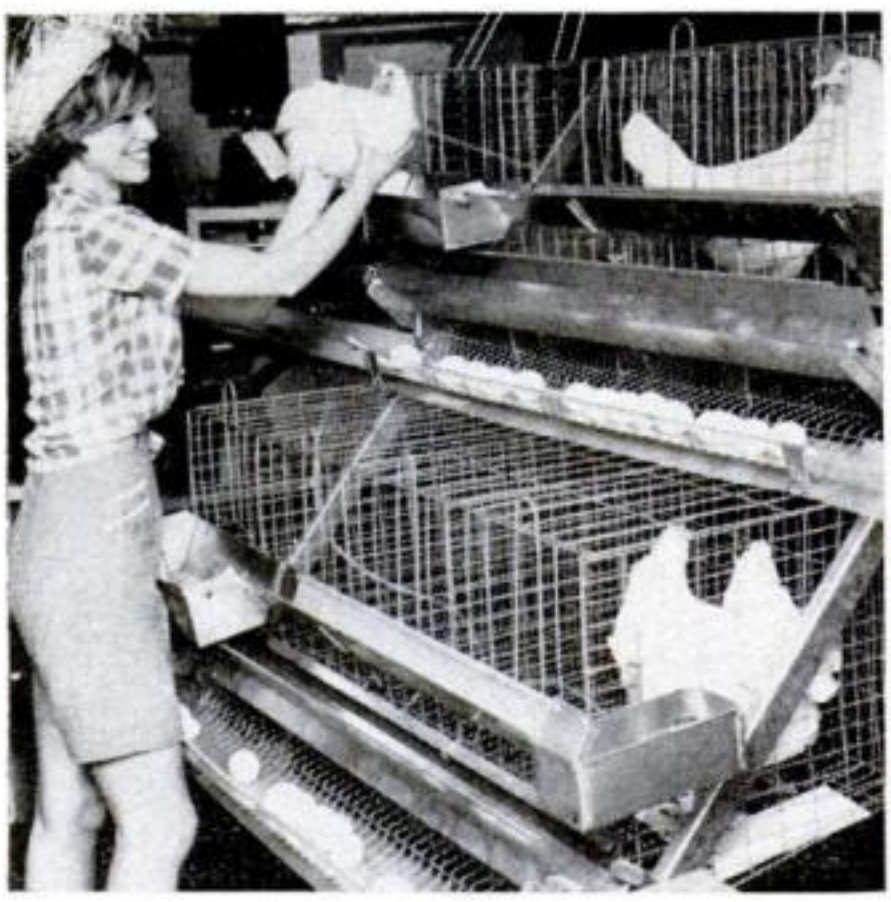


Dizzying view for fairgoers

Besides taking visitors to the top of the 300-foot theme tower, a two-level observation platform at the International Exhibition of Transport at Munich makes three revolutions while going up or down. An elevator encircling the tower, it provides a magnificent view of the fairgrounds, city, and Alpine-mountain chain in the distance.

New glasses help partially blind see

Eyeglasses with lenses that look like tiny binoculars are said to enable partially blind persons to read newspapers, watch television, even drive automobiles. Dr. William Feinbloom, New York optometrist, says his Tele-Cone glasses for distance viewing give triple magnification, and those for reading and close work magnify six times. They weigh only two ounces.



Automation comes to the hen house

One conveyor belt pops food into mouths of hens in this chicken coop; another on a lower level carries eggs off as soon as they are laid. As long as the hens keep eating, they keep laying in this rural version of give and take. The automated poultry farm was displayed at the American Trade Center in Frankfurt, West Germany.

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New Volkswagen is a fastback

This new 1600 TL is a sports-flavored five-seater derived from the VW 1500. Its rear flat-four engine is upped to 96.6 cu. in. to deliver 65 hp. at 4,600 r.p.m. with twin carburetors. Top speed is 85 m.p.h. Disk brakes in front are combined with rear drums. A rear luggage rack holds 10 cubic feet, the front trunk another 6½.

Rider dangles skis from new lift

No need to remove your skis to ride the new lift on Vermont's Mount Snow. The floorless cabin lets you hang your feet out, skis and all, when seated. Doors at the front slide into its shell as the car comes up behind you, then close automatically when you sit down. Made in Italy, the new lift is the first of its kind.

Caboose hauls passengers' autos

Passengers on the C & O-B & O between Chicago and Washington can now take their automobiles with them for use at their destination. The railroad has added a two-deck open-side freight car to its passenger trains for the first time in this country. Each deck of the carrier will accommodate three automobiles driven aboard.

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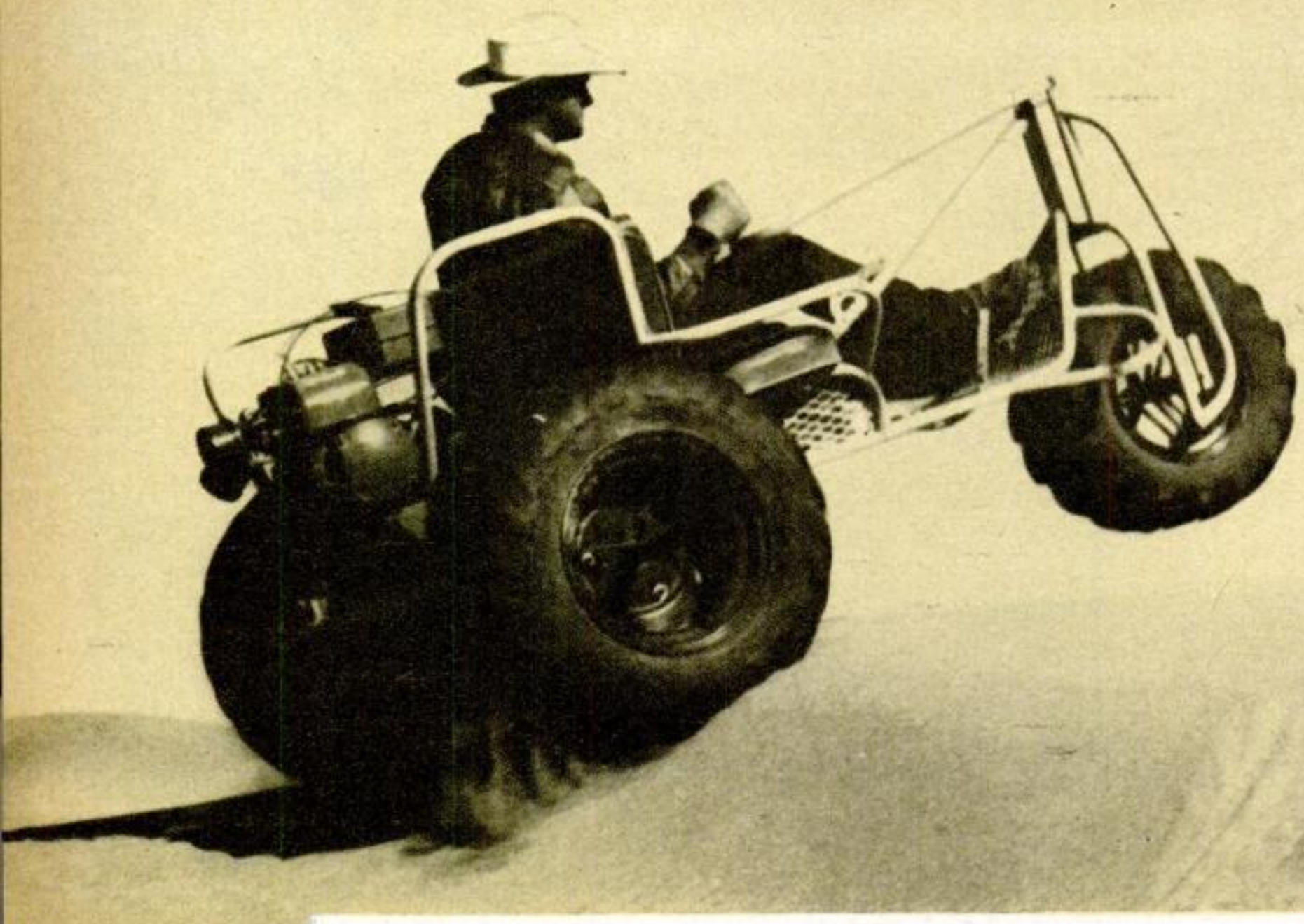
My Love Affair with



MAN is ever ready to meet the challenge of the unknown. Pressurized capsules are being repeatedly hurled into space containing astronauts who circle the earth every 90 minutes, who even get out and "walk" in space. But those experiences are reserved for a favored few.

For many years the desert was a deadly barrier to progress. When I first started adventuring in a camp wagon—a house bolted on a pickup—the desert fascinated me. I would travel around the rim and occasionally over desert roads into the desert itself, a lot

CONTINUED

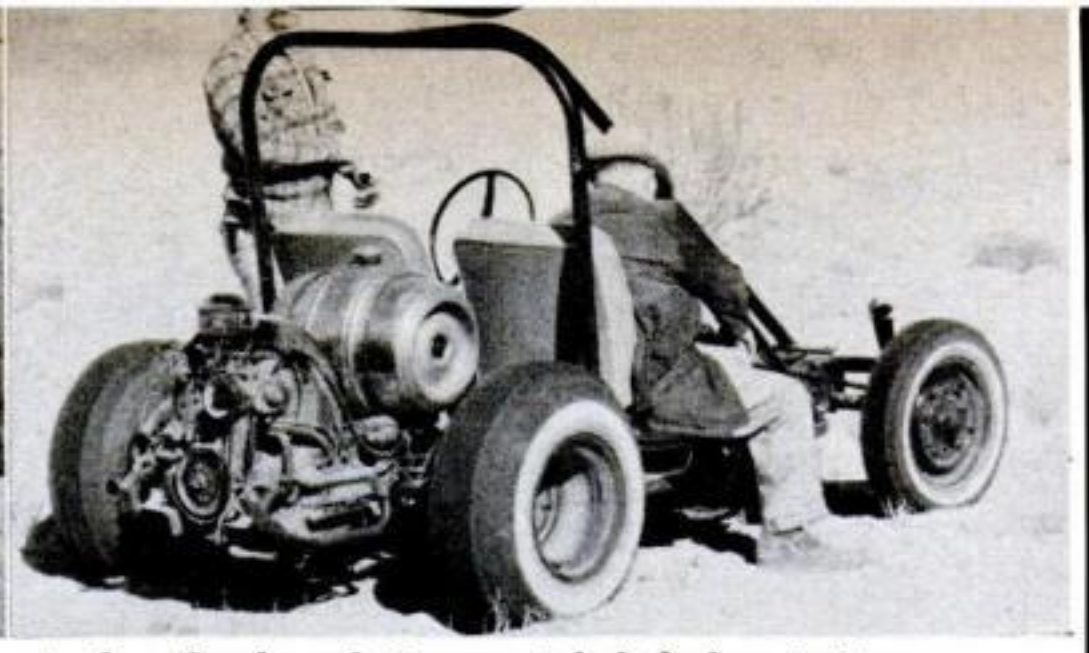
Sand and Wheels

By ERLE STANLEY GARDNER

Although best known for his courtroom scenes, the creator of Perry Mason has a real passion for the rugged, forbidding lands of our western deserts. Here he tells about the strange vehicles in which he explores remote areas and looks for lost mines–and about a Desert Run

Erle Stanley Gardner poses with the Butterfly (seen in action at left), one of fabulous desert vehicles.

Astride a Pak-Jak he designed for himself, J. W. Black crosses a crevice. His rugged scooter proved so popular that he sold many of them, launching a series of "adventure" vehicles.



Author Gardner fastens seat belt before testing Grasshopper on the desert sand. Also designed by Black (standing), the Grasshopper is a stripped-down VW equipped with a roll bar.

farther than I should have gone. (In those days getting off the desert roads was sheer suicide.)

Then came the military Jeep, and with many other sportsmen I waited impatiently until civilians could get them. When that day arrived, I bought two, equipped them with oversize tires and winches, and started tentative explorations of the desert.

Someone conceived the idea of cutting the edges off two rims, welding them together, and mounting a huge tire on them for sand work. Soon the "dune buggy" was engaging in competitive contests over the drifting sand hills of the deserts of the Southwest.

I was right in the vanguard of all this experimentation. In fact, I probably was ahead of it because as soon as helicopters became commercially available I worked out a deal with the Hiller Company of Palo Alto by which I could use their helicopters in my explorations.

I wanted to get into places in the desert that no human foot had ever trod.

Mounts for explorers. Then J. W. Black of Paradise, Calif., started a weird line of off-the-trail vehicles. When I first knew Black, he was running an ordinary, or rather extraordinary, machine shop. He would repair anything for anybody: tractors, caterpillars, mining machinery, pumps, road-building machinery, anything. If a machine had ever run, Black knew how to make it run again.

Then he became interested in desert adventure, and built a two-wheel, heavy-duty scooter for his own use. He called it the Pak-Jak. So many people wanted Pak-Jaks that soon Black was busily engaged in turn-

Once a deadly barrier to the explorer, the desert has become

Desert "run," sponsored by four-wheel-drive clubs, is gala family occasion involving upwards of a thousand people. Members gather at desert camp site on Friday night. Run is held on Saturday, followed by barbecue and other weekend camp activities. Photos show a small portion of one such camp site, and (far right) long line of four-wheel-drive vehicles at beginning of a run.

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ing them out. Next he decided to make a smaller, lighter edition of the Pak-Jak that wouldn't carry quite as much camp stuff, but would have more speed and flexibility. The Burrito appeared and the demand increased.

Following the Burrito, Black designed the Butterfly—a three-wheeled affair with dual treads on each wheel. I bought one and explored Baja California with it. Then came the Grasshopper and, as far as I am concerned, he hit the jackpot.

Black takes a Volkswagen frame, strips off everything except the fundamentals, shortens the frame, puts on roll bars, lowers the center of gravity, and fixes a series of brakes so that braking can be applied to the left side, right side, or both sides at the option of the driver. He widens the rims to 11 inches, puts on high-flotation tires, and is able to drift over sand with the greatest of ease.

I have bought three Grasshoppers, and the work they do is absolutely incredible. We have gone out in the desert in soft, powdery sand and skimmed along like a tumbleweed. We have gone up into the sagebrush country of northern Nevada where at times we had to use the machines to batter our way through roadless country covered with sagebrush seven or eight feet high. We have looked for lost mines and explored country where I am satisfied very few people have ever been.

And by using helicopters to haul Burritos over precipitous mountain ranges and down into unexplored canyons, I know I have been places where no other human being has ever set foot in modern times.

We have seen wild animals that didn't know what a human being looked like. On one occasion, bighorn mountain sheep stood and looked us over, curiosity predominating, but nerves on edge, muscles tense for take-off, while I talked to them and photographed them from not more than 100 feet away.

I remember one huge flock of quail that stared at us incredulously, banded into a tight circle, while a cock quail—evidently the kingpin of the outfit—came forward to look us over and at least intimated he'd be glad to take us on in mortal combat one at a time. It never occurred to that quail to be afraid.

These adventures, too, are available to only a favored few.

The ruggeds. The mass manufacturers are turning out four-wheel-drive cars by the thousands today, and these cars are being snapped up by an eager group of adventurers who want to go places and do things. The Japanese Toyota and the Datsun, the new Ford Bronco, the Jeep, the International Scout, even the standard pickups, all open up interesting possibilities.

The desert, which was a nightmare menace only a few years ago, is now one of the most fascinating playgrounds you can find. It is dangerous, of course, if one has mechanical trouble, runs out of gasoline, or has flat tires. But modern desert explorers go in groups and are learning to know and love the desert.

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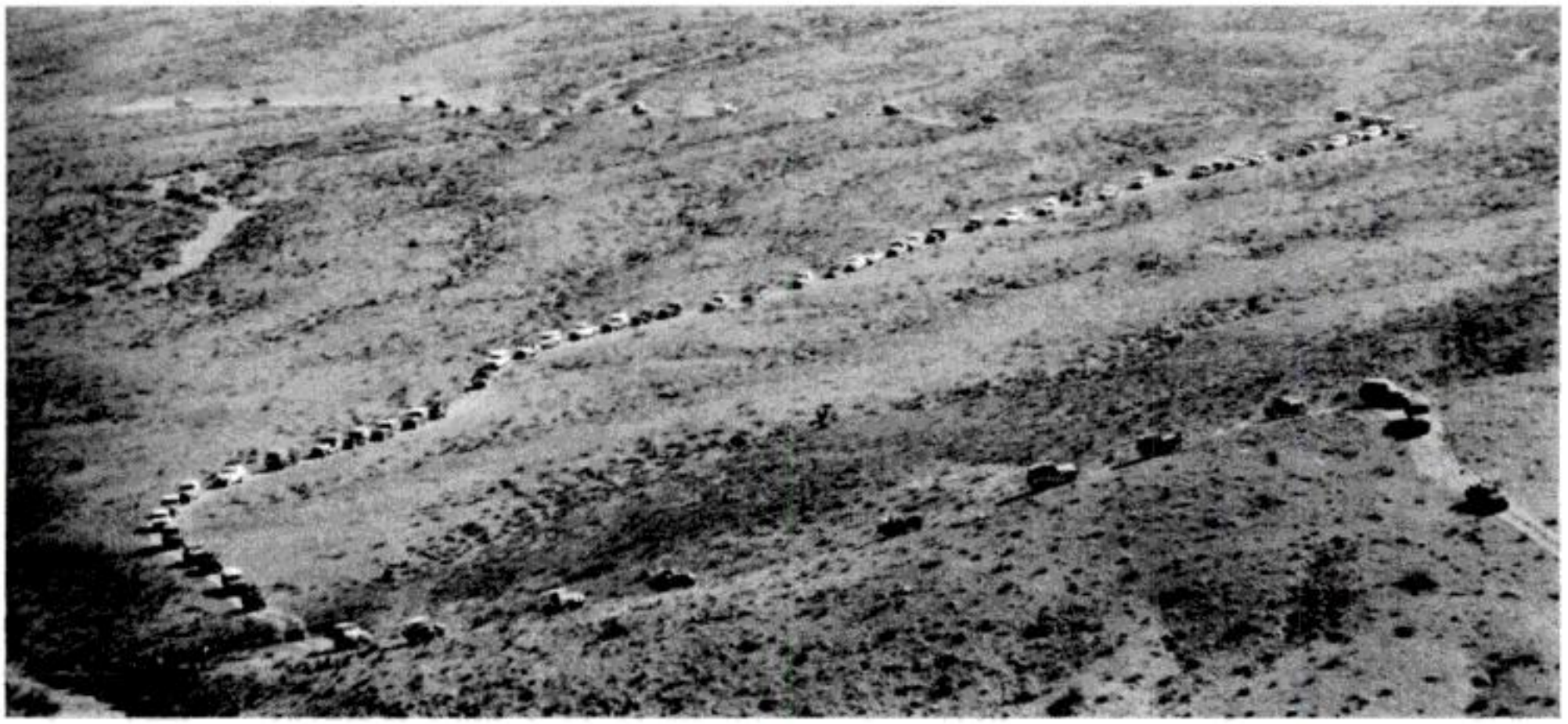
a land of adventure for the four-wheel-drive enthusiast



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Men and machines pit themselves against sun, sand, rugged

A few decades ago, this sandy waste was known by only a handful of venturesome prospectors. Every year the desert claimed its toll of lives. People who ventured out onto the shimmering, heat-tortured sand during the summer months in the underpowered automobiles of the day were in trouble almost from the start, even when they kept to the roads. Narrow, high-pressure tires were constantly getting stuck in loose, drifting sand. The drivers ran out of water, got in a panic, tried to walk out through the heat, and many of them left their bones bleaching in the desert.

Today, the owner of a four-wheel-drive automobile, if he is a skillful driver, can go into parts of the desert that were literally unexplored a few years ago. Desert travel has proved so exciting that it has become a separate sport, as exhilarating as boating, water skiing, or snow skiing in the mountains. Four-wheel-drive clubs are growing like weeds.

Almost every club member is a pretty good back-yard mechanic. If he isn't when he joins a club, he becomes one shortly afterwards. These people become adept at transposing powerful motors, adapting overdrives, installing power winches, cutting and welding tire rims to take high-flotation tires. They pep up the motors so that the cars will go through deep drift sand as though it weren't there, climb hills that seem almost perpendicular, and roar and snort their way over terrain that would challenge a burro.

Virtually every weekend, club members are out in the desert exploring, collecting rocks, and locating routes for their "runs." These runs have to be experienced to be believed.

Four-wheel-drive city. On a typical run, a couple of dozen cars pull into the camping place on Friday afternoon. As the sun sets, the tempo increases; and, by midnight, there will be a city of 300 to 400 cars and 1,000 to 1,200 inhabitants where 24 hours before there was empty desert. Recently I attended a desert run sponsored by a group of four-wheel-drive clubs.

Steady stars blazed down on the Southern California desert when we arrived at our destination. The silence of the night was broken by the exhaust of a gasoline-powered generator furnishing enough electricity to illuminate a teeming tent city.

A thousand people were within a circle of a half-mile radius. Yesterday no one had been there, and two days later the city would vanish like a mirage. But tonight the place looked like a motion-picture version of a new gold strike.

By daylight Saturday morning the camp started to come to life, and by eight o'clock, the line began to form. It was a remarkable line—three or four hundred vehicles, all waiting to fall in and take part.

Driving a four-wheel-drive vehicle on one of these runs calls for considerable skill as well as first-class equipment. Most of the cars were equipped with Citizens Band radios, and the long whiplike antennas carried a small pennant showing the colors of the club to which the owner belonged.

After the line had been formed and the run started, the leader brought us to the first hazard—a short, steep, downgrade. It plunged almost straight down the sides of a canyon to the sandy bottom, wound around a point, and then abruptly climbed up out of the canyon on the other side.

Some of the drivers made this first upgrade the first time they tried. If the cars are handled skillfully, the drivers don't have too much difficulty. But some drivers misjudged the slope. They either started in second gear and then tried to shift halfway up the slope to the low, low gear, or they started out in low, low gear and gave the wheels too much power so that they started spinning.

Either way, the results were disastrous. The car began to dig itself in, a cloud of dust billowed up, and, in many instances, the car started swinging sideways. This is the danger point. If the car gets sideways on one of these steep grades, it is quite apt to roll over, perhaps over and over.

Most of the cars are equipped with roll bars. With these heavy bars enclosing the car, and the driver held in place with seat belts, the car can roll over and over without the driver sustaining any serious injury.

The clubs accept these accidents goodnaturedly. The last man to roll over has to have his club emblem mounted upside down on his automobile, and he can't put it back right-side-up until some other unfortunate rolls over.

The skillful driver, however, keeps his car pointed straight ahead and, the minute

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it starts to skid out of control, throws it into reverse and backs down to make another charge at the steep slope.

The course. A good course for a run must be so difficult that it is a challenge even to a good driver, yet not be *too* dangerous. The clubs try to prevent roll-overs as much as possible.

The course should provide variegated desert scenery, canyons filled with verde trees and smoke trees, steep climbs, knife-edge ridges, narrow passageways, twisting and turning canyons, and at least one slope so steep that it can properly be labeled "The Point of No Return." Once a driver heads down one of these almost perpendicular descents, there is no possibility of getting back out. He has to keep on the course until he arrives at the end.

By the time 350 cars have charged one of these slopes, you can imagine the condition of the terrain. It is full of holes where previous drivers have spun their wheels. The harder soil underneath has been churned into deep dust and, as the run progresses, the course becomes increasingly difficult due to finely powdered desert dust.

As the slopes get steeper and steeper toward the end of the run, some of the less fortunate or less skillful drivers have to be winched up. Or, if they bog down near the top and can hold themselves in position, another driver who has already reached the top will toss down a rope for a tow.

Laying out a run calls for skill, daring, and a knowledge of exactly what a four-wheel-drive car can do and what it

[*Continued on page 190*]

Dust flies as cars scramble, careening up one side of knife-edged ridge, down the other. It takes nerve and skill to plunge down nearly perpendicular slopes into canyons below. Latest driver to overturn mounts club emblem upside down on car until someone else is unlucky enough to roll over.

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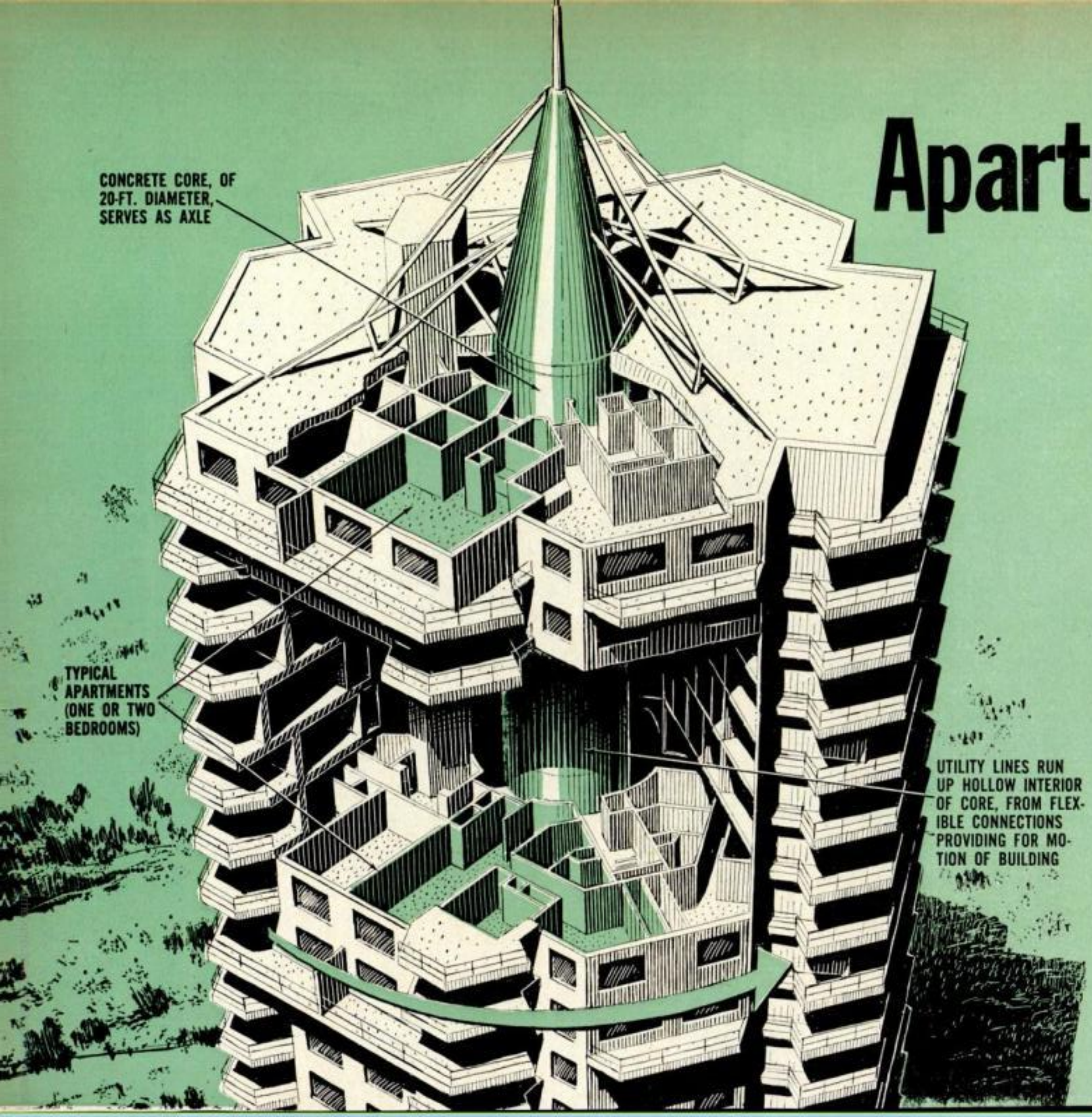

CONCRETE CORE, OF 20-FT. DIAMETER, SERVES AS AXLE
TYPICAL APARTMENTS (ONE OR TWO BEDROOMS)
UTILITY LINES RUN UP HOLLOW INTERIOR OF CORE, FROM FLEXIBLE CONNECTIONS PROVIDING FOR MOTION OF BUILDING

Apartment House Rotates to Change the View

SEA, shoreline, and mountains will parade before the windows of a revolving apartment house planned for La Jolla, Calif. To give occupants the changing view, the whole building will turn around once in three hours—and then, back again.

An electric motor of only 10 hp. will suffice to rotate the 21,000,000-pound structure. Through newly invented gearing (so far undisclosed but shown schematically), it will turn the building's supporting core—a hollow "axle" of concrete extending downward to hydraulic bear-

ELEVATOR SHAFT

REVOLVING LOBBY

ENTRANCE

UNDERGROUND PARKING

SPROCKET DRIVEN BY MOTOR TO ROTATE BUILDING

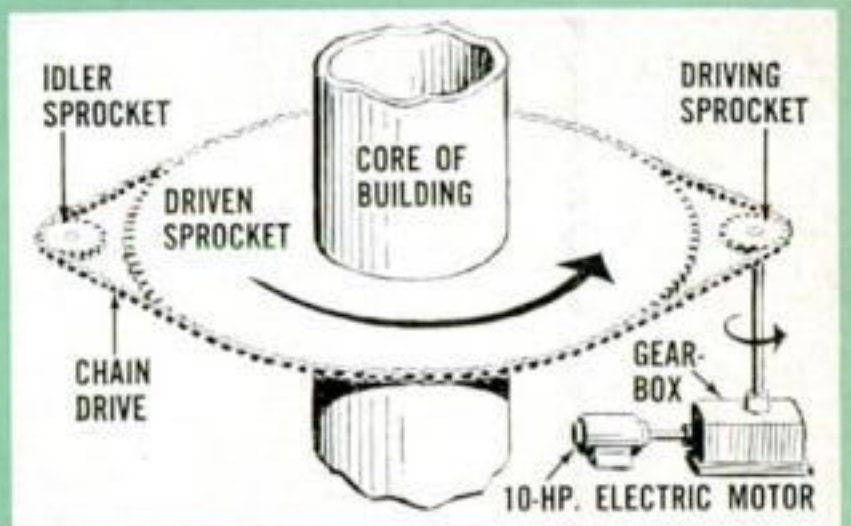
RADIAL THRUST BEARINGS

MAIN THRUST BEARING

SERVICE TUNNEL

ings 50 feet underground. Depending on whether steel or concrete framing is chosen, the 18 to 24 floors either will be hung from roof girders, or will individually cantilever outward from the core. The mobile apartment house's San Diego architects, Paderewski, Dean & Associates, call it the first of a group of six to rise ultimately on a 30-acre site atop Mt. Soledad, the highest point in the San Diego area.

—John J. Fry



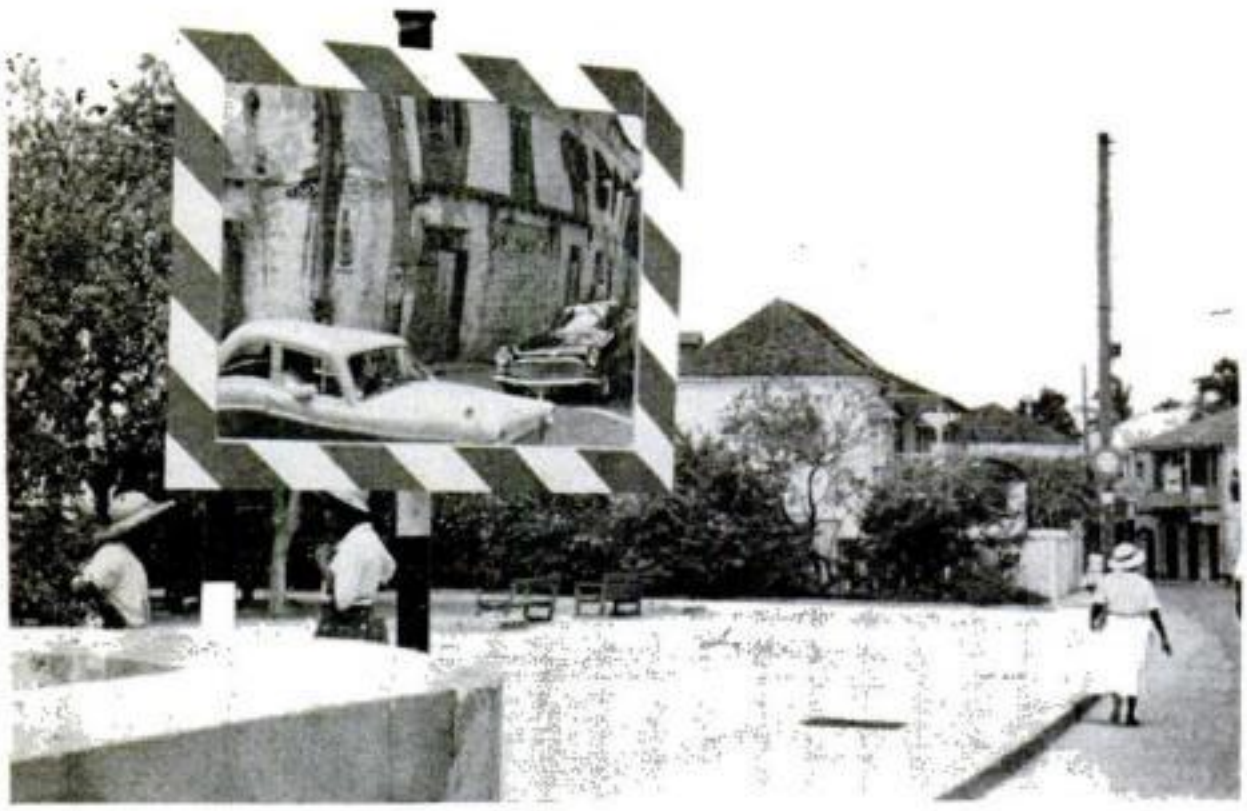
Schematic drawing shows how geared-down electric motor will turn the core to rotate entire building pictured in large view.

Ray Prectt

King-size grill broils steaks for crowd

Designed for the man who has everything, including lots of friends, this outdoor grill can broil 150 steaks at a time, 300 servings of chicken, or hot dogs for an army.

Five feet in diameter, the grill is moved up and down to 14 positions by a swivel post at the rim of the firebox or rotated if required. It's made by Hall Machine & Tool Works, Bakersfield, Calif., for use in public parks.



Mirrors help traffic see around corner

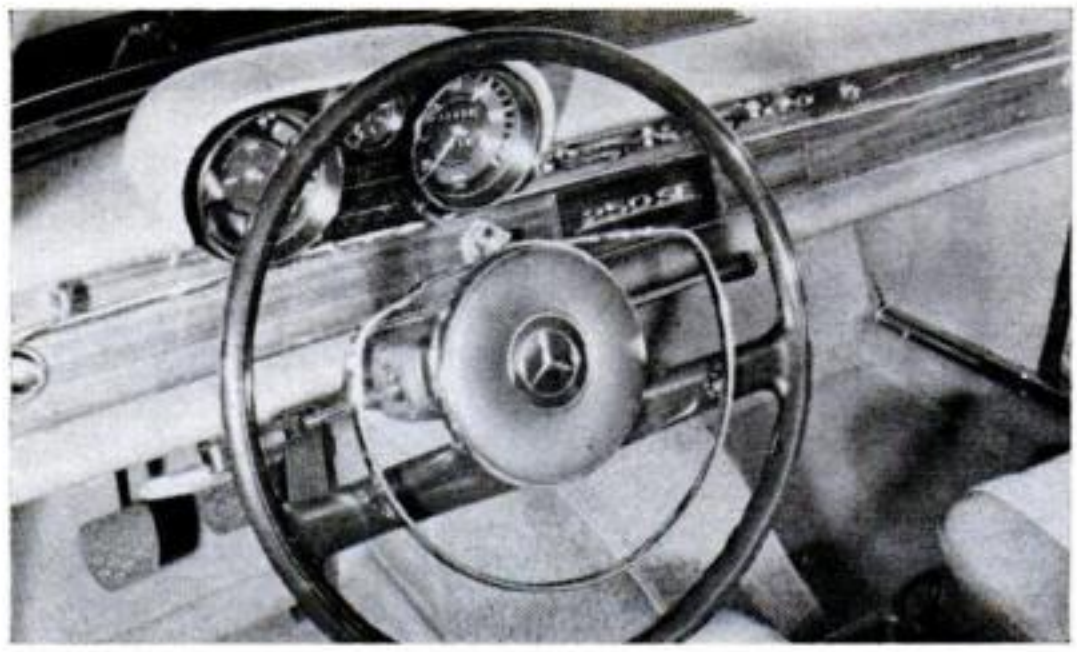
Mirrors at blind corners have become an important accident-prevention aid on the narrow streets of Bridgetown, on the Caribbean island of Barbados.

Rigged at eye level by the local authorities, they reflect oncoming traffic. Approaching motorists can see other cars blocked from view by buildings at the corners.

Lower and sleeker Mercedes-Benz

Planned for U.S. import next spring, the 1966 Mercedes-Benz luxury sedan will have a low, sleek silhouette with a flat roof line and rounded rear deck. A lowered hood and belt line provide more windshield and window area. The 250SE model will have 170 hp. and a top speed of 119 m.p.h. Disk brakes on all four wheels and a dual braking system are standard.

Safety features include padded dash, recessed instrument panel, padded steering-wheel center.



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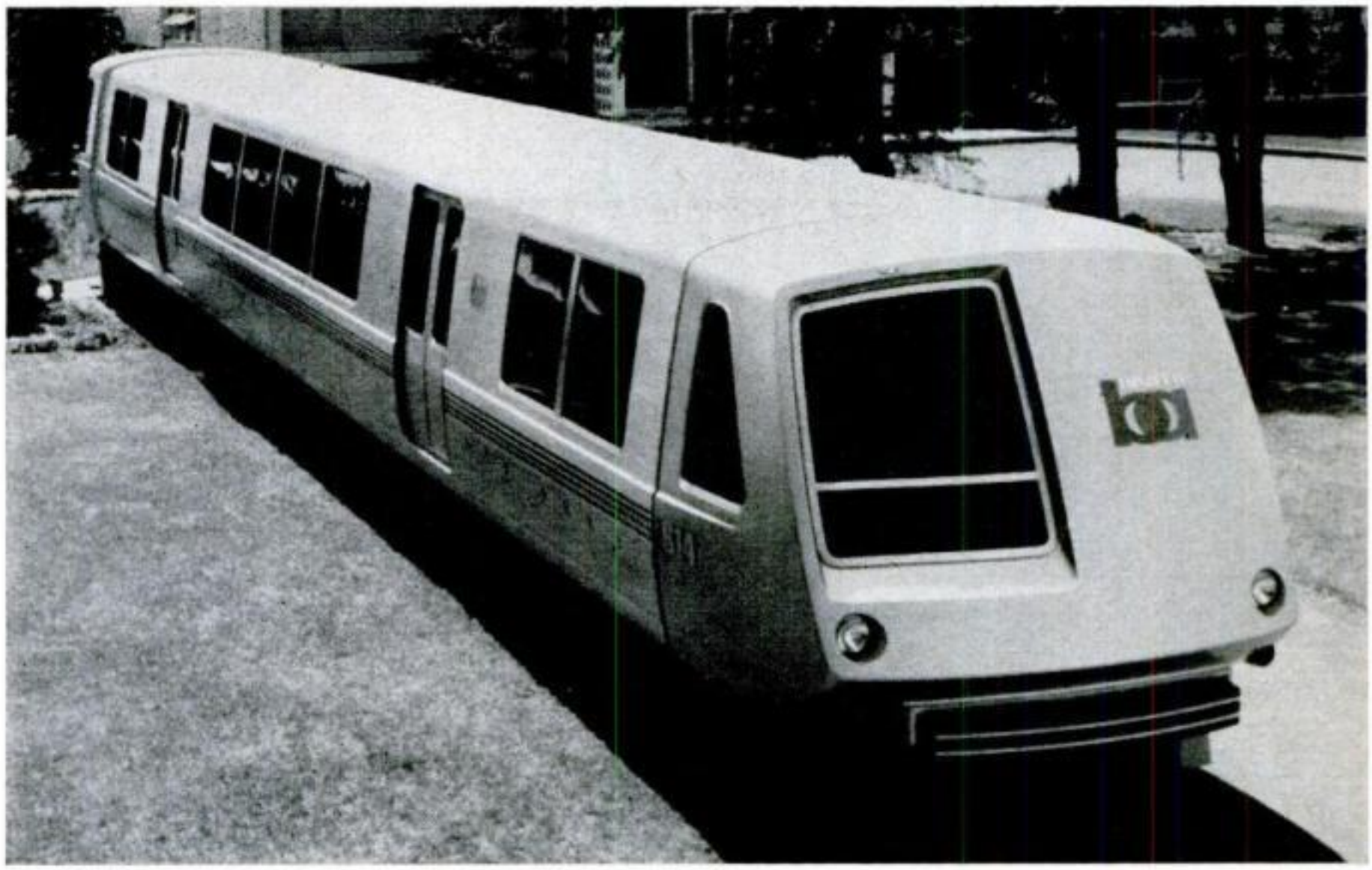


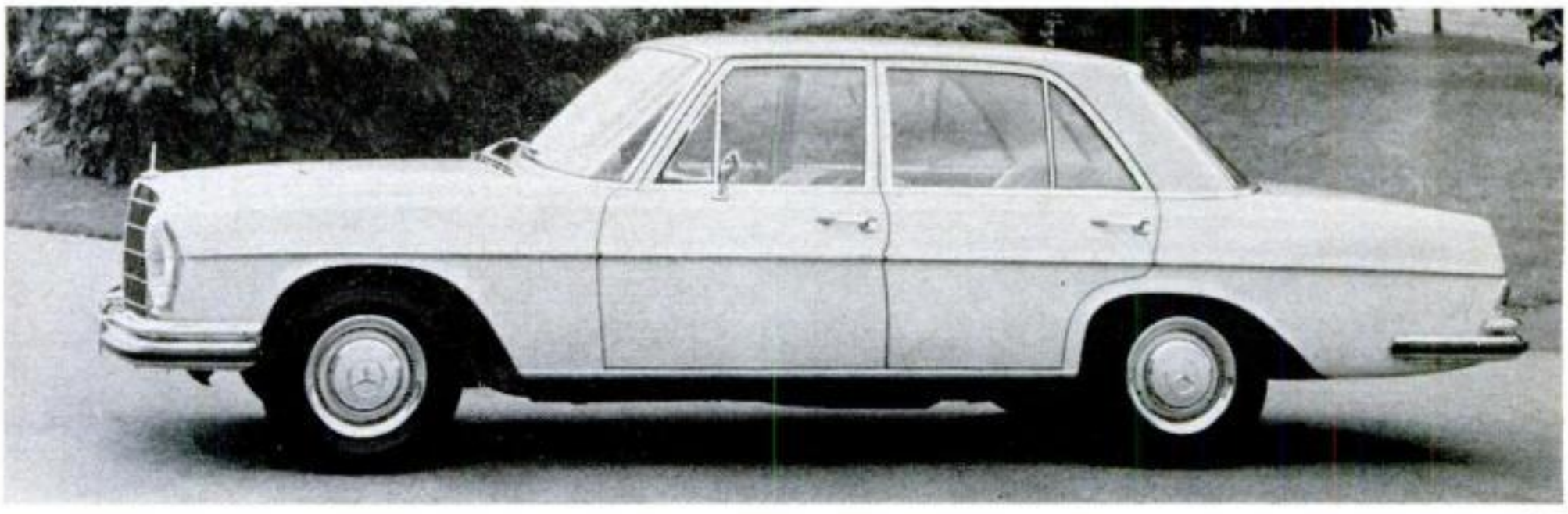
Cars seat 72 behind large expanses of tinted glass. Front and back control pods add streamlining.

Luxury rapid transit for San Francisco's Bay Area line

Pampered passengers will begin riding to and from work on a billion-dollar train in 1968 in San Francisco and other cities in the Bay Area. The cost covers rolling stock, 75 miles of track, and a four-mile tunnel under San Francisco Bay.

The new rapid-transit line will use blunt-end cars with streamlined wheel-less detachable pods at front and back containing automatic-control equipment. In an attempt to wean motorists from traffic-jammed freeways, the cars will be ultramodern, fitted with comfortable 22-inch-wide seats (four inches wider than usual) for 72 riders. Straphanging will be discouraged. Temperature will be controlled with air conditioning through the sills under large tinted-glass windows.

Luxurious interior resembles swank club car, caters to rider comfort.



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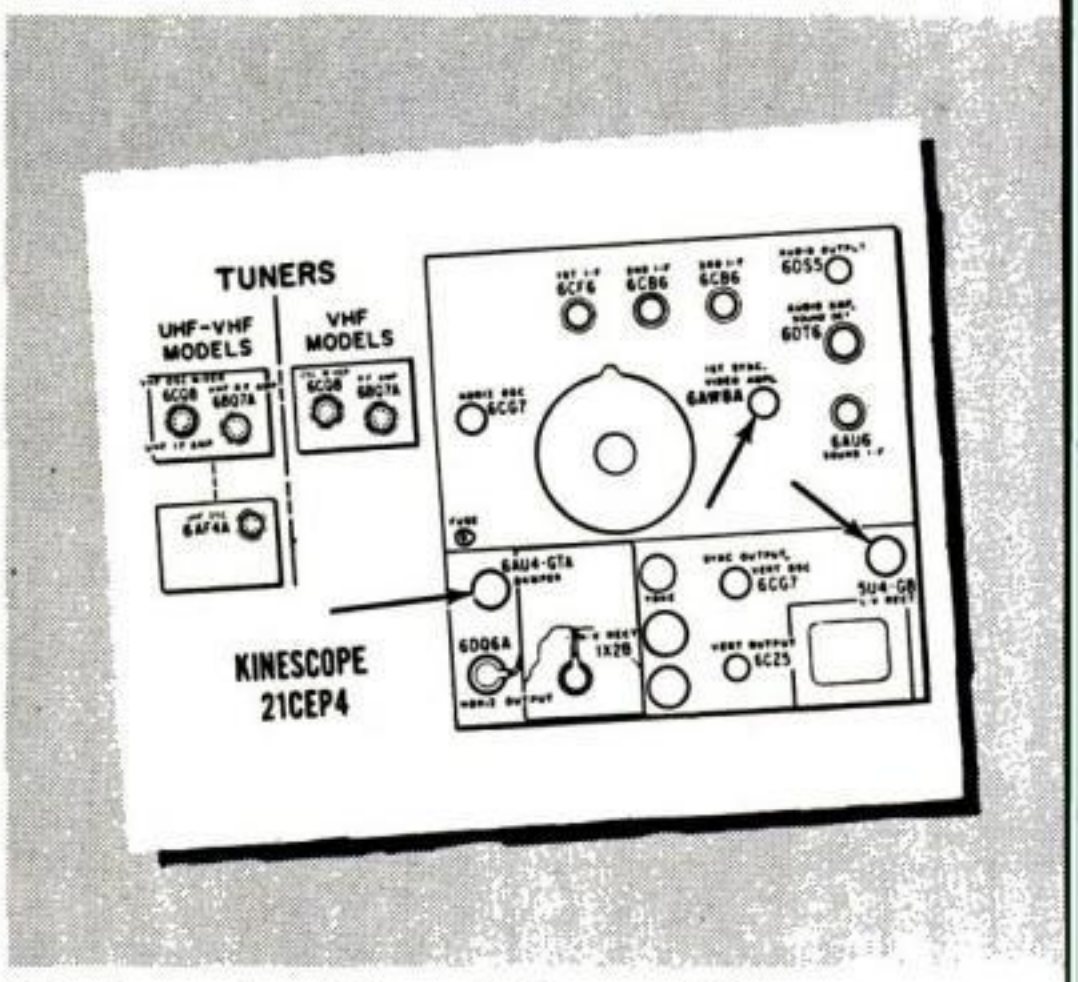
10 Sure Ways to Improve Your TV

By Ronald M. Benrey Electronics Editor

HOW'S the picture on your TV set? As good as the day you bought it? If not, there's a fault somewhere.

Here are 10 sure poor-picture cures. One of them probably can remedy the fault in your set. But before you search for a complicated malady, make sure your TV's "up-front" controls are set for the best possible picture. Like so:

• Brightness and contrast. Switch to a strong local channel and turn both controls to minimum (full counterclockwise). Advance brightness slowly; stop when you see a dim glow on the screen. Turn up contrast until a dim picture, having normal contrast, is visible. Now adjust brightness



1 Repair mechanical faults. The most common are corrosion and poor electrical connections. They can strike any of your set's scores of sockets, contacts, and switches, but usually cause the most trouble in the sensitive tuner and i.f. (intermediate-frequency) stages.

The characteristic symptoms are: "noisy" or smeared picture, multiple images on the screen, poor brightness, and loss of definition. Often, the fault is intermittent— the trouble comes and goes randomly. Striking the set may cure the problem temporarily, but a lasting fix requires more informed action.

Check for loose and corroded antenna lead-in connections, and loose or missing tube shields. Make sure the shield bottoms are grasping clean metal. Remove tubes and examine their base pins—they must be bright and clean. Use a fine emery board to clean away corrosion. Remove and replace the tubes two or three times to scrape off corrosion in the socket pins.

2 Replace aging tubes. As vacuum tubes age, their characteristics change—usually not enough to yell for a serviceman, but enough to degrade the picture you see. Often, such tube deterioration won't show up on the simple emission-type tester at the drugstore.

If the picture has gradually become washed out or noisy, and picture definition is poor, try replacing the r.f. (radio-frequency) amplifier tube. Check its location on the tube chart inside the cabinet—the one above is typical.

Gradual loss of contrast, and excessively white picture, combined with picture jitter and instability, mean a weak video-amplifier tube.

Lack of brightness, poor focus, shrinking of the picture at all four edges, and "blooming" (increasing picture size as scene brightness increases) may be caused by a weak low-voltage rectifier tube.

A weak damper tube causes poor horizontal linearity and a gradually narrowing picture.

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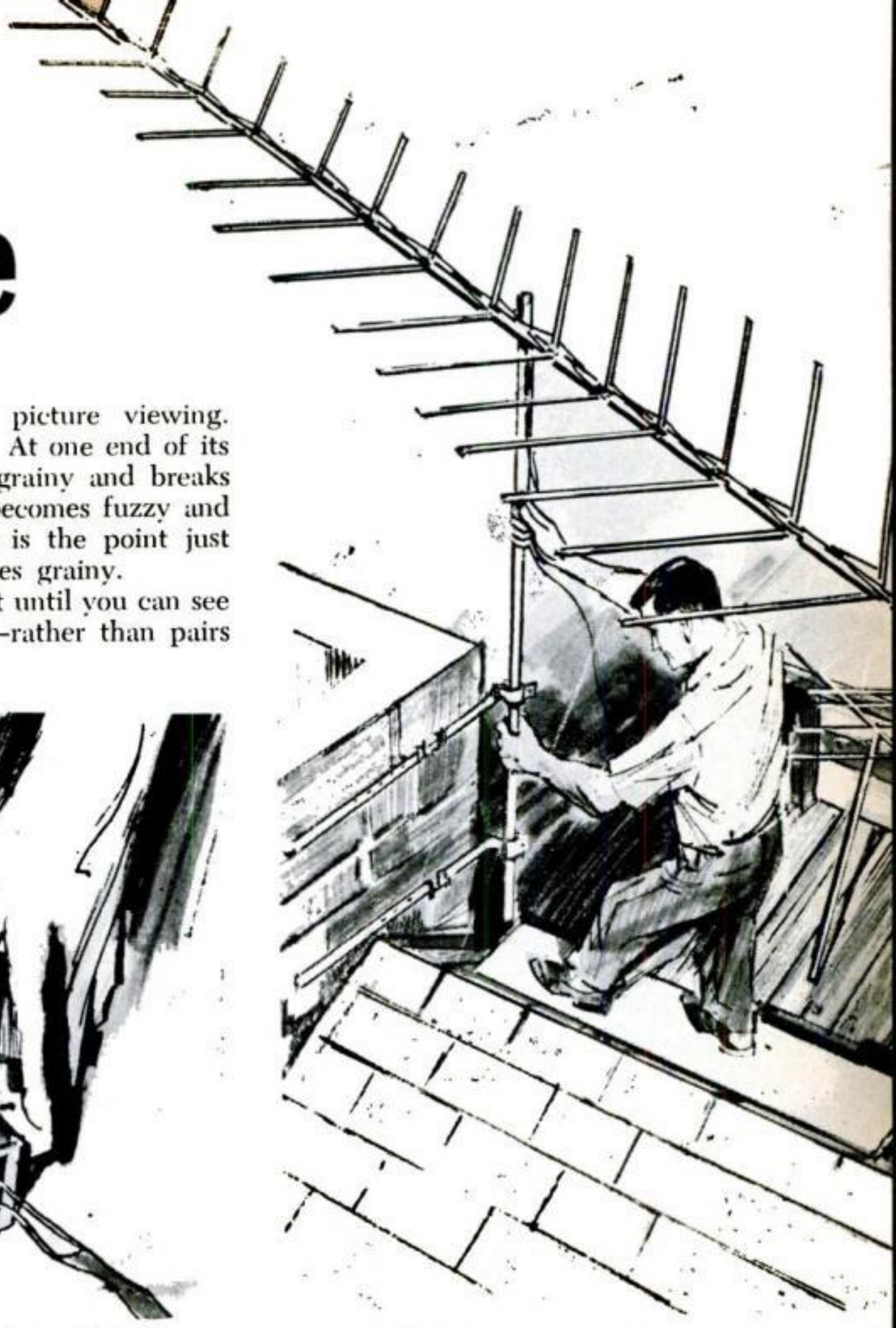
Picture

to what is normal for picture viewing.

● Fine-tuning control. At one end of its range, the picture turns grainy and breaks up; at the other end, it becomes fuzzy and blurry. The best setting is the point just before the picture becomes grainy.

● Vertical hold. Adjust until you can see individual scanning lines—rather than pairs of lines—in the picture.



3 Check twin-lead. It's an oft-overlooked cause of ghostly, snowy, and poorly defined pictures. Start by tightening all connectors and cleaning corroded terminals.

The twin-lead between antenna and set must be as short as possible—excessive length increases signal loss in the line, weakens the television signal that is delivered to the set, and may cause snow.

Straighten sharp bends or twists in the lead—these cause signal reflections within the lead that generate ghost images. Reroute the line if it passes through metal tubing (including the antenna mast) or lies near masses of metal (like window frames, gutters). Nearby metal alters the line's electrical characteristics—another cause of ghosts.

If the twin-lead is over three years old, worn insulation may be short-circuiting the signal. If you find hairline cracks and discolored insulation, replace the entire line.

4 Replace the antenna. A snowy picture is positive proof that the TV signal reaching your set's antenna terminals is much too weak: It isn't strong enough to blot out tiny noise signals in the r.f. stage that produce snow.

Look at the picture closely—if it is snowy but has good contrast, the trouble is probably in the twin-lead; if the contrast is also poor, chances are your antenna is to blame.

Antennas wear out for several reasons [see "Is Your TV Antenna Out of Date?" PS Jan.]. Corroded terminals and elements, deteriorated insulators are key factors. Equally important is wind damage: After several seasons in the open, many of an antenna's critical elements will be bent out of shape, or broken off, destroying its carefully calculated geometry.

Hint: If you replace your present antenna, be sure your new one is designed to receive color broadcasts. You may switch to a color set during the next few years.

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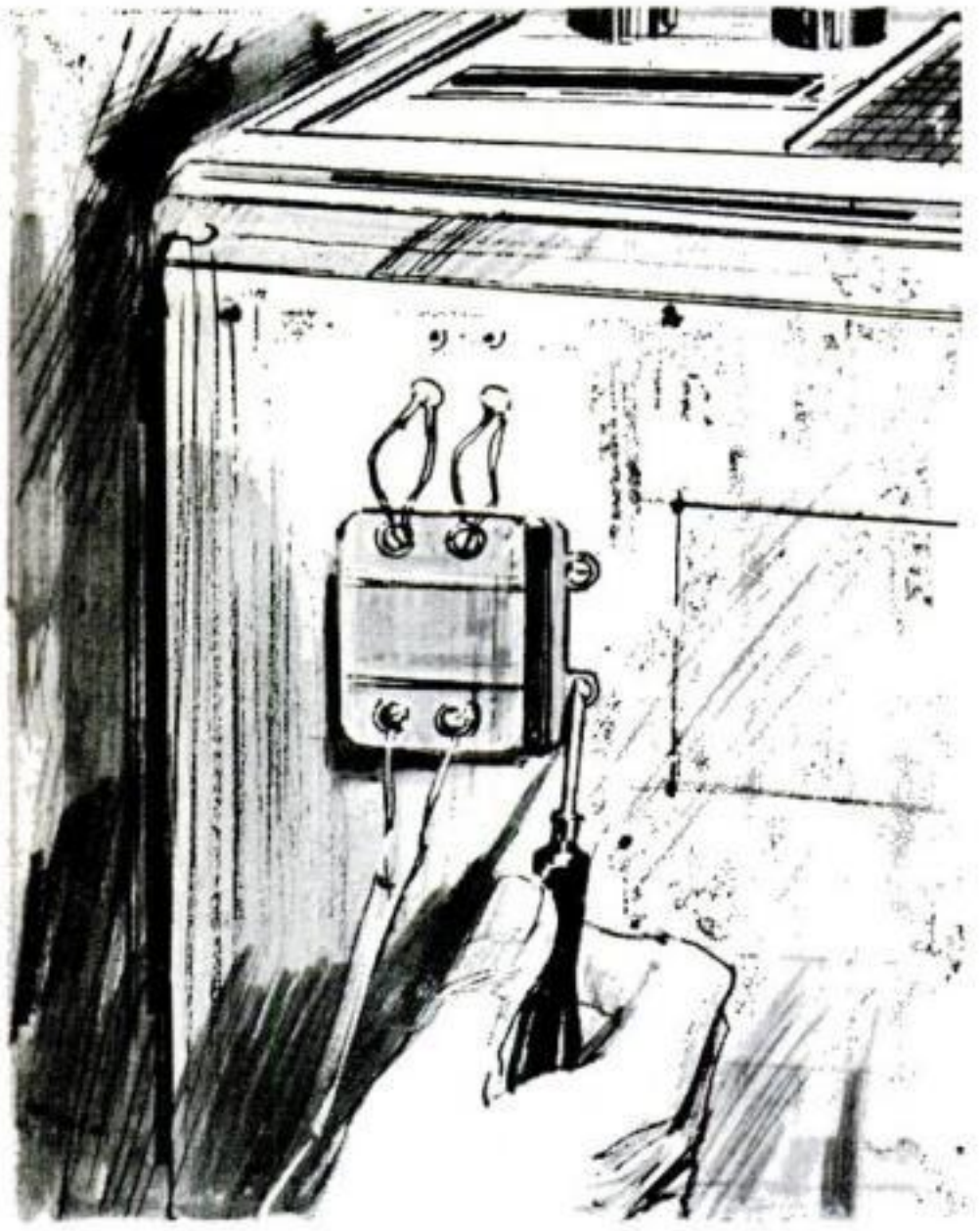
5 Install a CRT "booster." It's a temporary cure at best, but one that nearly always restores the fading performance of an aging CRT, or cathode-ray tube.

A picture tube starts dying when its cathode begins to deteriorate—it gradually loses its ability to emit electrons. The symptom is a dim, washed-out picture.

The booster—or "brightener"—is a compact transformer that mounts on the CRT's socket in tandem with the base-connecting pins. It steps up the voltage applied to the CRT's filament from 6.3 to about eight volts, making it burn hotter. The higher filament temperatures squeeze the very last available bit of useful emitting life from the cathode.

How long will it work? It's impossible to predict: The improvement may last a few days or a few months. Considering that a booster costs a dollar or two—a fraction as much as a new picture tube—it's worth a try.

Be sure you install the right booster. It must be suitable for use in your set. Some work only in sets using parallel-wired tube filaments; others are designed for series-wired filaments. Check your set's specs before you buy.



7 Eliminate interference. The first step is to identify the interference disturbing the picure. Then the appropriate countermeasure can be applied.

Dark horizontal lines—sound bars—are produced by the interaction of the received signal's own sound and picture components within the i.f. stage. Adjust the fine-tuning control to stop it.

Ghosts are caused by reflected TV signals that bounce off nearby objects—a bridge, water tower, high building—before they strike the antenna. They travel farther than the direct signal and arrive slightly later, from another direction, producing secondary images. A highly directional antenna that can be carefully aimed to exclude the ghost signal is the only practical cure.

Alternate dark and light bars, which may be arrayed vertically, horizontally, in a herringbone pattern, or a series of smooth curves, most often result from stray, unwanted r.f. signals striking the antenna. A few of the many sources are medical diathermy machines, CB and amateur radio transmitters, and oscillators in nearby radio and TV sets. The simplest solution is a "high-pass" filter (about $2 from most electronics suppliers) connected in series with the set's antenna leads. The filter allows the high-frequency television signals through, but does an efficient job of blocking out lower-frequency interference.

Urheberrechtlich geschütztes Material

6 Update the CRT. A modern picture tube will often make a veteran TV set perform like a showroom model for a fraction of the cost. Recent circuit developments cut down the number of tubes, shrink chassis size, and lower cost—rather than boost performance. Much of the credit for a new set's better picture goes to improved phosphors and cathodes, aluminized screens, bonded safety glass, and better quality control in manufacture.

As a rule of thumb: A replacement CRT costs about $1.75 an inch, less a small trade-in for your old tube.

Is your set worth it? Design engineers claim a well-built TV has a useful life of 10 years. Your serviceman can tell you if the chassis in your set is basically sound. Have *him* install the new CRT (in an older set it's tricky work).

8 Boost AC line voltage. If it's too low—less than 105 volts AC—the picture will probably lack brightness and be prone to blooming. The cure is a line-voltage adjuster, or "regulator," sold by electronics supply houses.

Incorrect line voltage can do more than spoil the picture—it may damage the set. Most TVs are designed to work at a nominal AC voltage of 120 volts. The bulk of their components will take moderate differences, above and below, in stride.

The tubes, though, are especially sensitive.

Excessive line voltage—over 130 volts—rapidly accelerates tube burnout, since their filaments are running at higher-than-rated temperatures.

Low line voltage may damage permanently the CRT's finicky cathode by forcing it to operate at below-rated temperatures: The relatively cool cathode can absorb impurities within the tube, contaminating it, and causing its emission to drop.

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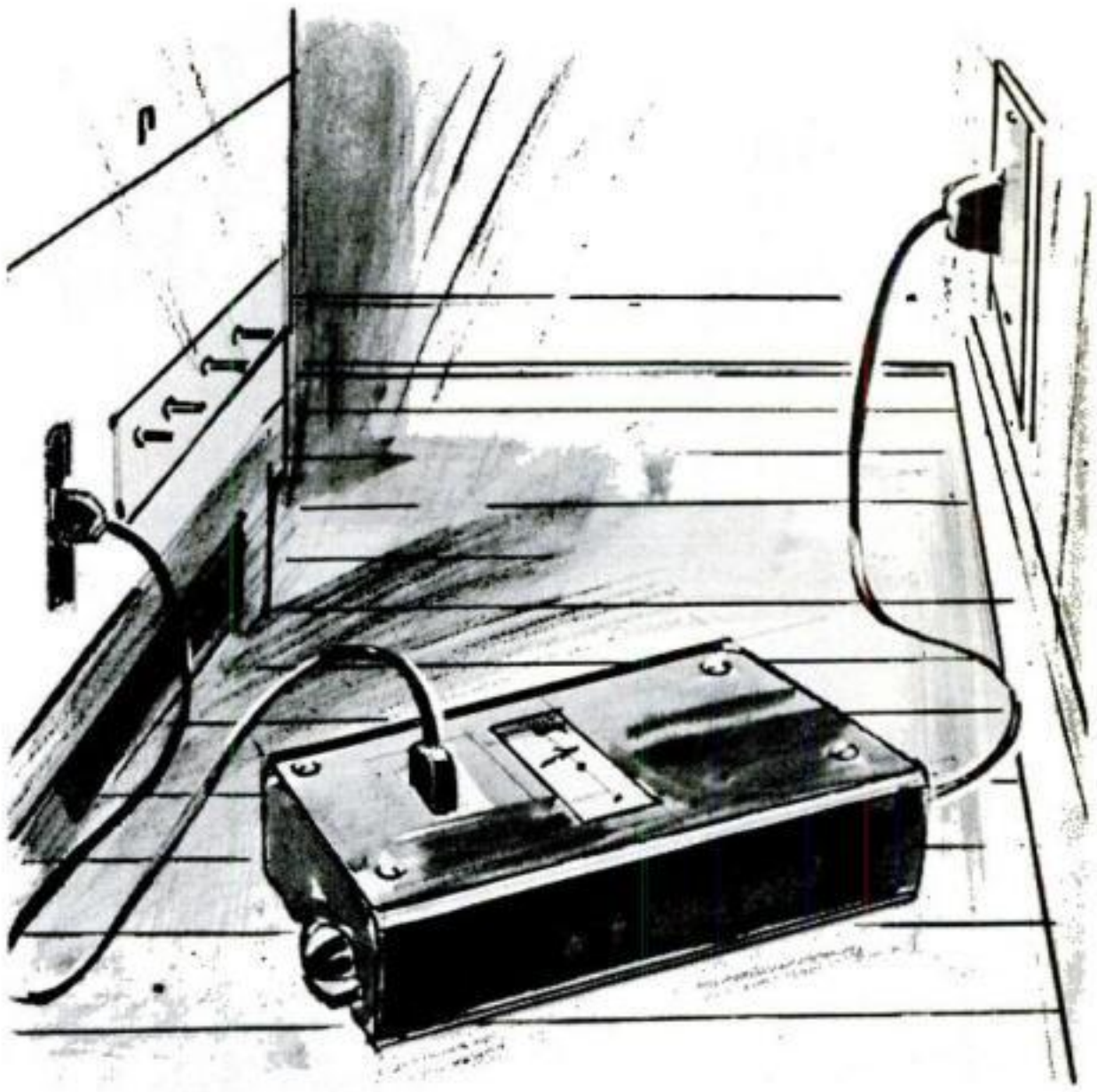

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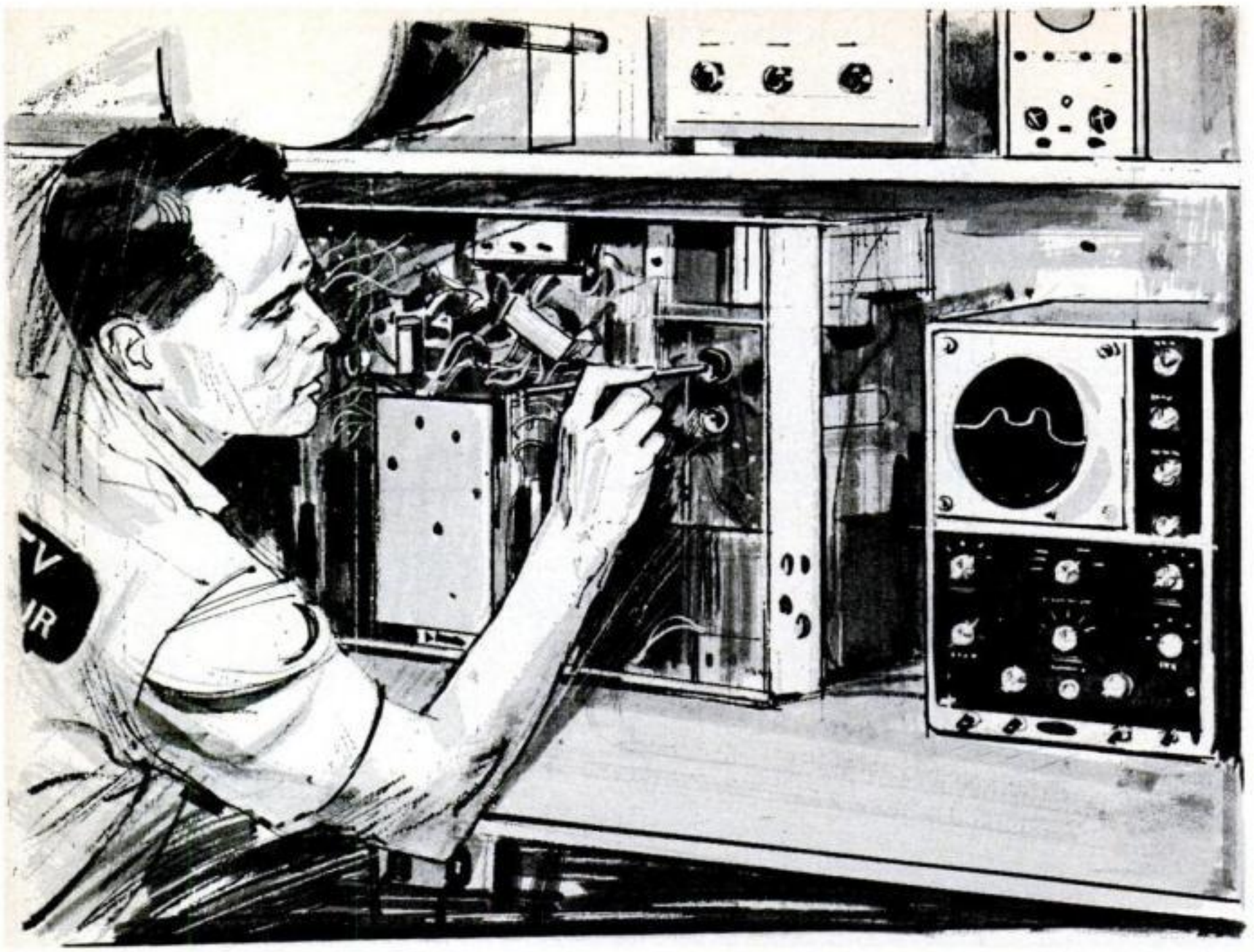
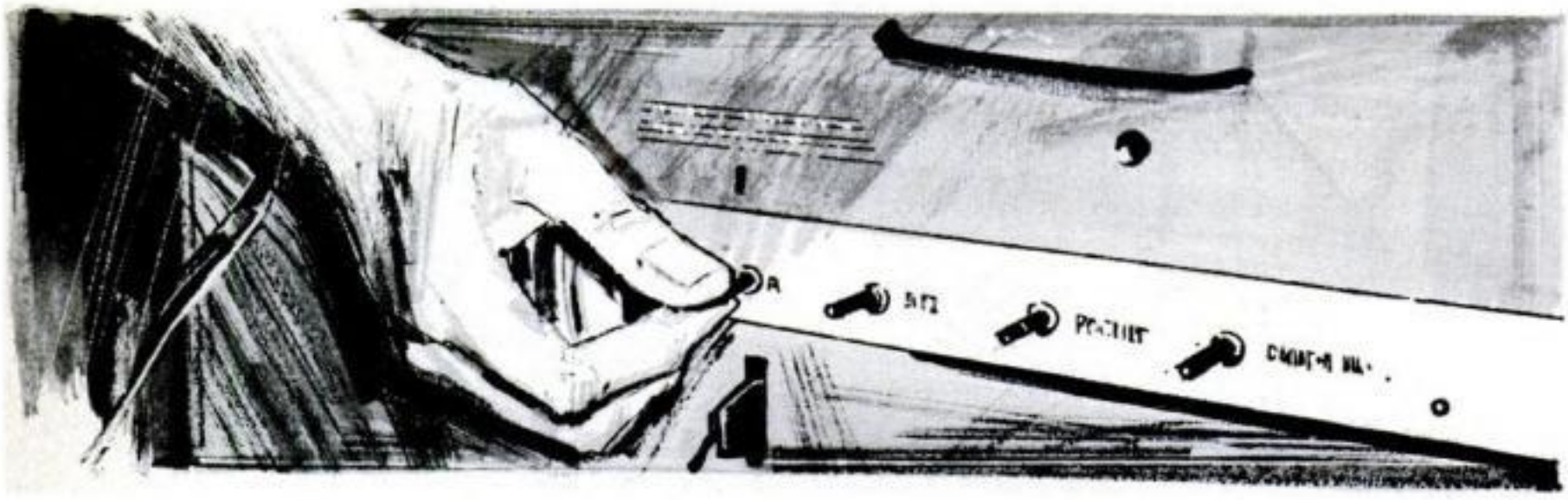


9 Get a professional "tune-up." Like your car, your TV set must have periodic maintenance to keep performing at its best. Even the simplest set has roughly 20 different under-the-chassis adjustments that were carefully made when the set was built. In time, as the chassis components age and change value, many of them drift away from their optimum value. Readjusting them properly requires the talents of a skilled TV serviceman, and a shelf-full of specialized instruments. Just two important adjustments:

Realigning the tuner stage—its frequency-bandpass characteristics are critical. If the tuner passes too narrow a band of frequencies, picture detail is lost; if it passes too wide a band, contrast suffers and the picture becomes unstable, and displays sound-bar interference.

Realigning the i.f.-stage traps—these remove interfering, near-frequency video and sound signals from the desired i.f. signal. Trap tuning is critical. A slight misadjustment will show up as weaving black lines and sound bars in the picture that vary with the sound volume.



10 Touch up the back-panel controls. Most of them should be left to a qualified serviceman. Three that often need minor adjustments can usually be reached without removing the set's back. Use an insulated screwdriver if the controls don't have knurled extensions.

Automatic gain control: Adjust if a properly tuned-in picture (broadcast by strongest local station) is too dark or becomes negative. Advance the AGC until the picture tears; back off until the last trace of tear or bend is gone.

Vertical linearity and height: Adjust them in combination to correct vertical distortion and expand a shrinking picture. The height control varies the total picture height; the linearity control varies the upper half of the picture. ■ ■

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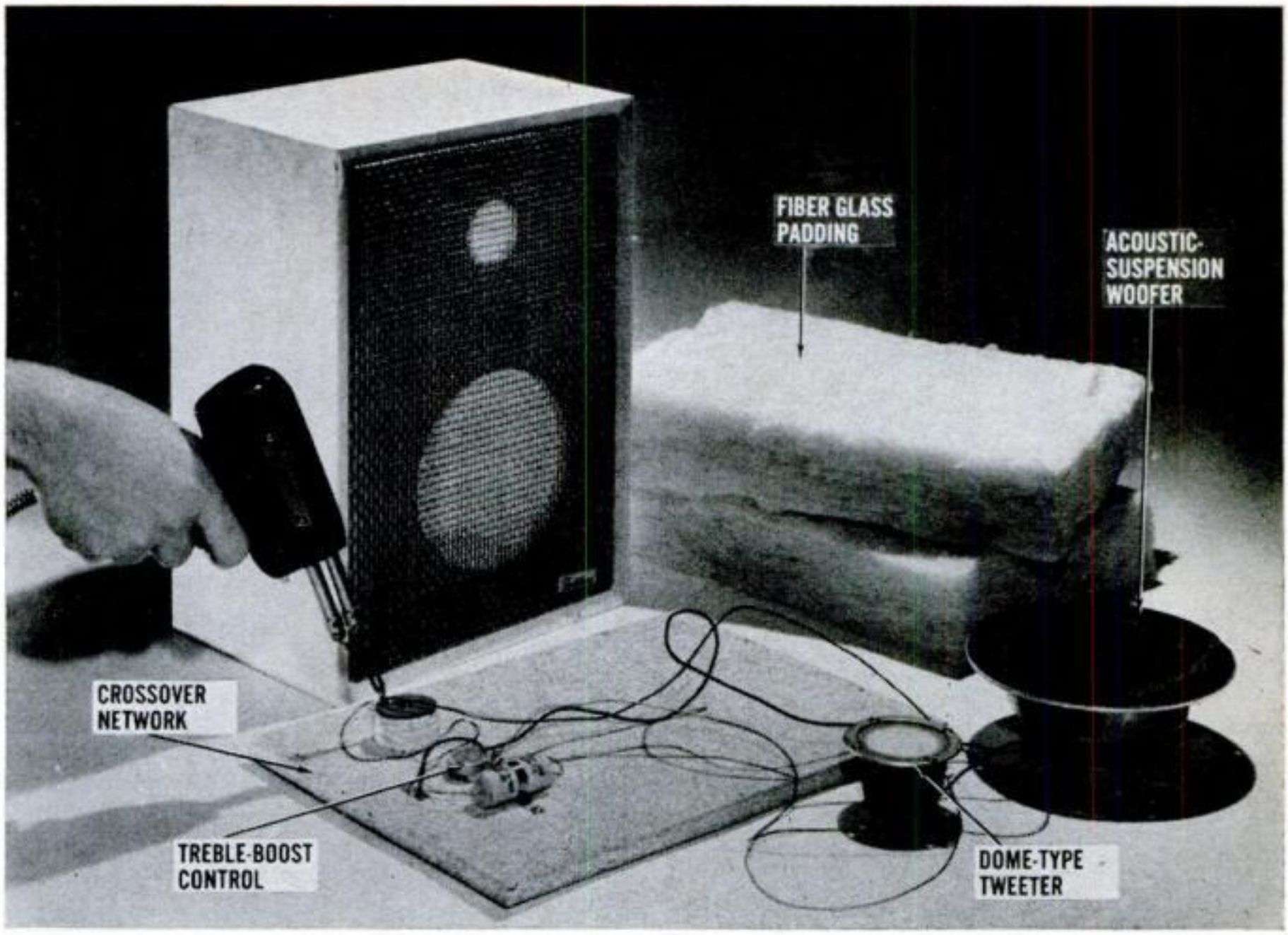

A compact, compact speaker—the Sonotone RMK-1 measures a scant 15 by 11 by 7 inches. You can build it in about 45 minutes.

what's new in ELECTRONICS

PERSONAL-USE REPORT:

A Compact Speaker You Build from a Kit

IN A single evening, I assembled a pair of Sonotone RMK-1 compact speakers, and then listened to them play several hours of hi-fi stereo music. Construction time: 45 minutes each.

The RMK-1 comes as a "semi-kit": Its unvarnished birch-veneer cabinet is completely assembled. All you do is mount the crossover-network components (one coil and one capacitor), bolt the woofer and miniature tweeter to the front panel, and stuff in the fiberglass acoustic deadening material.

The illustrated instruction booklet is flawless; it's impossible to make a mistake. Once completed, your speaker is identical to the factory-built RM-1.

How does it sound? Surprisingly good, considering its diminutive size and low $35.50 price tag. The six-inch acoustic-suspension woofer needs a generous helping of bass boost from my amplifier to reach tones below 50 cycles per second. And there's a slight—but noticeable—touch of twanginess in the treble passages.

Still, it produces a pleasant, listenable sound. It's worth your consideration if you're a budget-bound hi-fi buff, or don't have space for larger speakers. Sonotone, Elmsford, N.Y., makes it.—*R. Benrey.*

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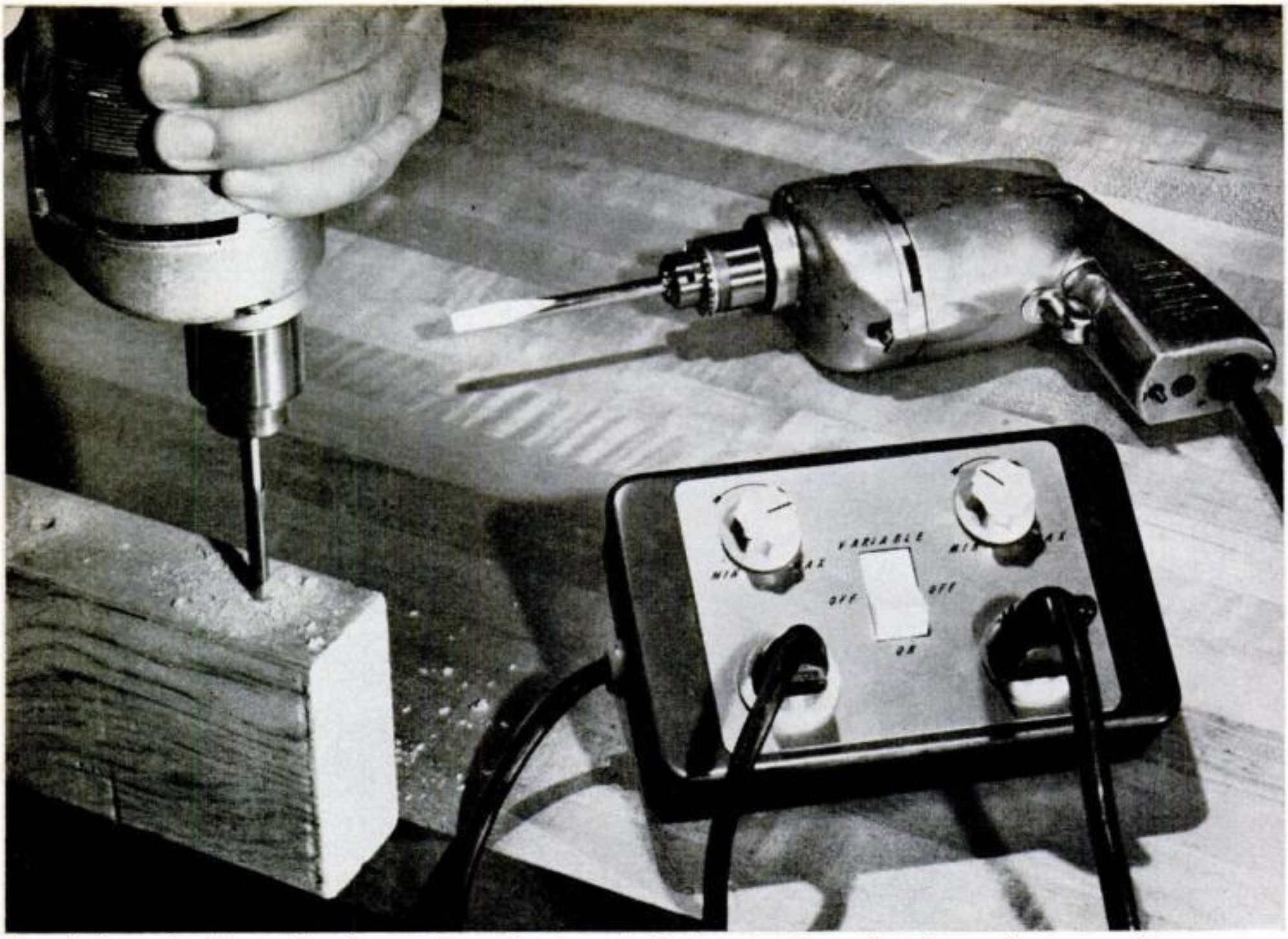

Two independently regulated speed-control circuits—each capable of handling 600 watts—save time when you use two power tools. Single-chassis design cuts down the clutter of power cables on your workbench. It's built out of readily available electronic parts. Total cost: $25.

BUILD YOUR OWN Dual-Throttle

Two "triac" power-control circuits in one package let you vary the speed of two tools without the nuisance of changing plugs

By Don Lancaster

THE only thing handier than one power-tool speed control is a pair of them—especially if they're both mounted in a single cabinet. They let you vary the speed of two different power tools without wasting time switching power plugs back and forth, or readjusting the power-dial setting. And the single-cabinet design means that only one power cord runs to the AC wall socket, so there's less of a rat's-nest of wires on your workbench.

The two speed circuits are controlled by a single three-position rocker-type switch: ON-OFF-VARIABLE. In the ON position, the speed-control circuit is bypassed and a tool plugged into one of the sockets operates normally.

In the VARIABLE position, its speed is controlled by the knob above the socket.

Each circuit will handle up to 600 watts—or about five amps of 115-volt AC current. Most handheld power tools fall well within this maximum rating.

There are also dozens of nonworkshop uses for the speed control. For example, either of the circuits will:

- Control the speed of any universal-type

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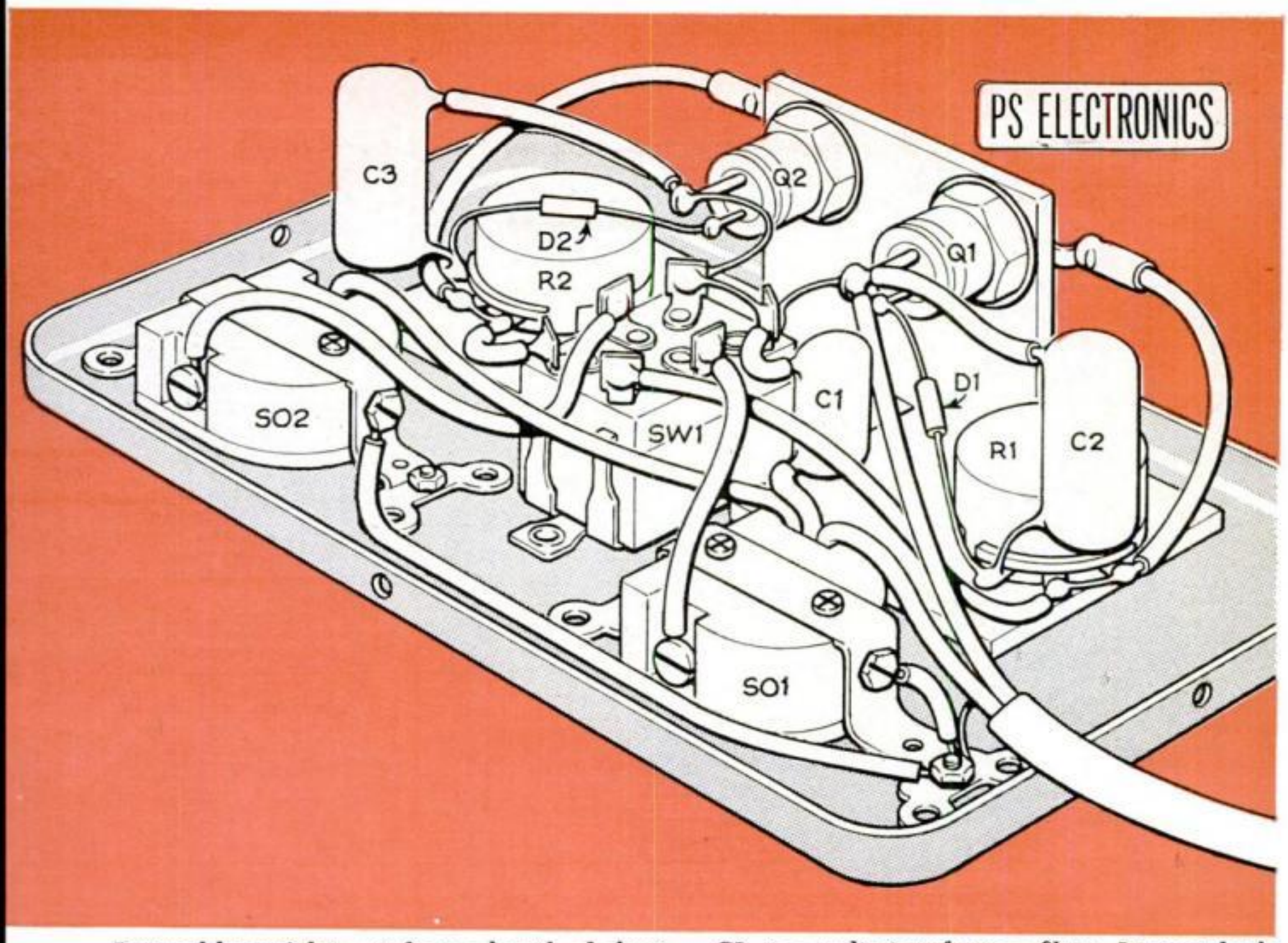

Internal heat sink is cut from a length of aluminum angle. Make sure that it sits flush against the case to insure good heat transfer. Capacitor CL is a radio-interference filter. It stops hash, generated by the triacs in the unit, from causing static on any AM radio that may be nearby.

Power-Tool Speed Control

AC-DC motor—the kind used in a wide range of motorized devices.

- Vary the heat output of a soldering iron or electric heater rated under 600 watts.
- Control the brightness of any incandescent light bulb—or bank of bulbs that draws less than 600 watts. (But don't use the control to dim fluorescent lights.)

How it works. Most conventional speed controls use a silicon-controlled rectifier (SCR) circuit; this one contains two identical triac circuits, each operating independently. The triac is a relatively new semiconductor device that, single-handedly, does the work of two SCRs and a handful of other parts. It's basically an electronic switch that is turned "on" when a short-duration current pulse is fed into its gate terminal. Once on, the triac allows current to pass through it. It turns off automatically whenever the current flow decreases to zero, and will not conduct again until another turn-on pulse is fed to the gate.

This turn-on/turn-off action is the secret of smooth power control. The triac is connected in series with the power tool and the AC line. By turning on the triac at varying times in each half cycle of the AC current, a varying amount of electrical power is supplied to the tool. If the triac is turned on early in the half cycle, nearly all the available power reaches the tool; a turn-on late in the cycle allows very little power to reach the load. Each time the AC current reverses direction, its value momentarily decreases to zero, turning the triac off and restarting

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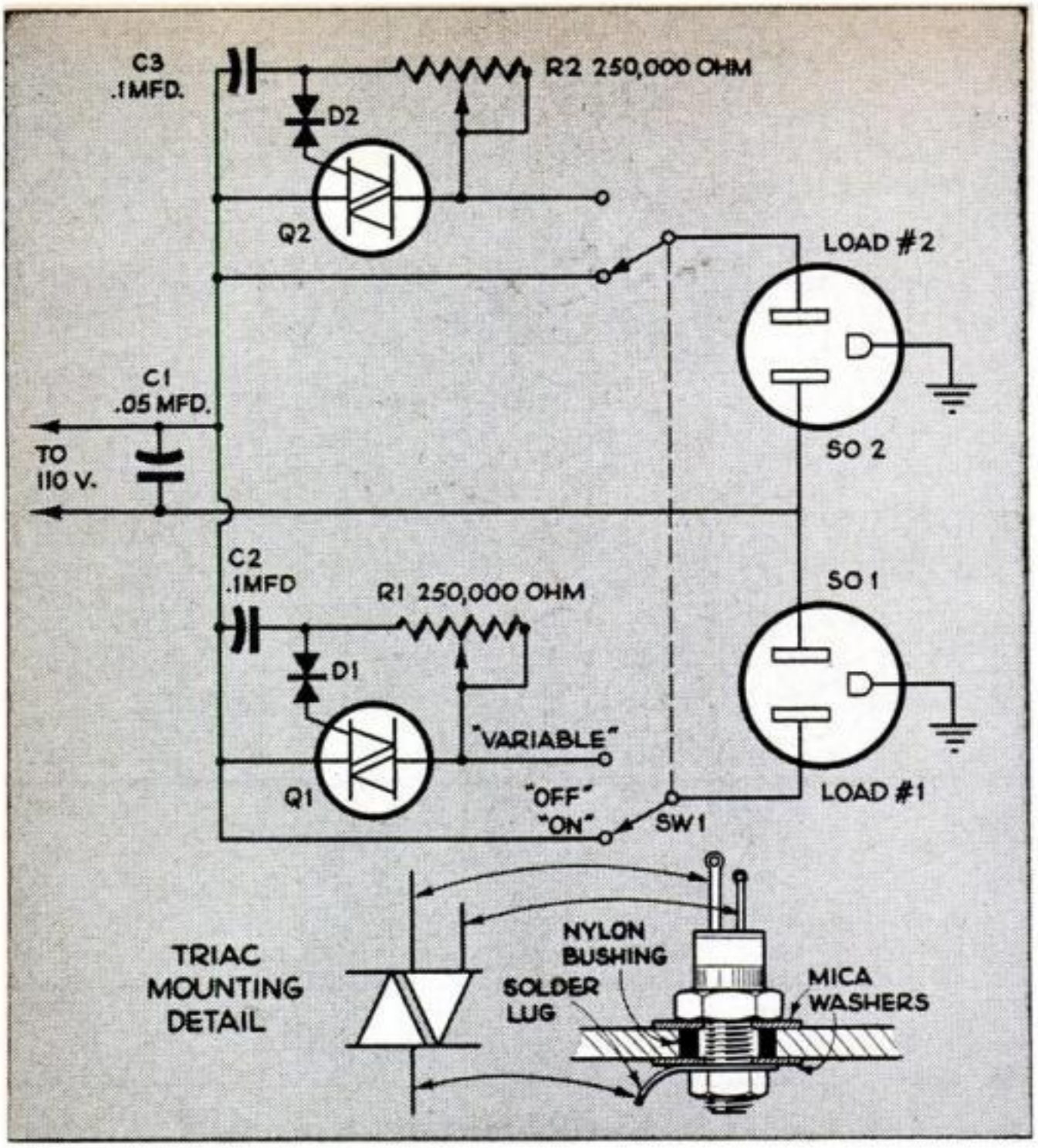


PARTS LIST

R1, R2—250,000-ohm, 1-watt carbon potentiometer, linear taper
C1—.05-mfd., 200-volt, mylar capacitor
C2, C3—.1-mfd, 200-volt, mylar capacitor
Q1, Q2—Triac, GE ZJ-257-B
D1, D2—trigger diode, GE ZJ-238
SO1, SO2—Female chassis-mounting AC receptacles
SW1—DPDT center OFF 15-amp rocker-type switch
Case—Matching case and cover, Z64-104A-26 and Z64-104-COT-5 are available for $5.15 from Zero Mfg. Co., Monson, Mass.
Misc.—Ten - foot - long heavy-duty three-conductor grounded-plug power cord; two insulating mounting kits for the triacs; silicone grease (Dow heat-sink compound); angle iron for brackets

the process. A variable resistor-capacitor circuit and a pulse-trigger diode control time in each half cycle that the triac is turned on, to give the desired proportional speed control.

Building it. The cabinet shown is a deep-drawn anodized aluminum box (see parts list). You can save money by using a conventional minibox or other utility case. Make sure the case is aluminum, though, since it serves a dual role as a heat sink for the two triacs. When they are operating, each dissipates about five watts of power as heat, and they get noticeably warm to the touch. The triacs are bolted to an internal heat sink, fashioned from a 5″ length of 1½″ aluminum angle iron that conducts the heat to the case.

The triacs must be electrically insulated from the internal heat sink. Check this with an ohmmeter. Use the two mica washers, nylon insulator, and solder lug supplied with the triacs. Make sure the aluminum angle is free from any burrs that could pierce the thin mica washers. Smear a small quantity of silicone thermal grease between the triac, washers, and heat sink when you mount them (it improves heat transfer to sink).

The internal aluminum-angle heat sink is held in place by the potentiometers' (R1 and R2) mounting shafts. The bottom of the heat sink must be smoothly finished and lie flush against the aluminum case.

Mount the diodes, resistors, and capacitors by soldering their leads to the appropriate terminals of the triac, potentiometers, and sockets. Use insulating tubing on all exposed leads. Don't overheat the diodes when soldering them in place.

Use #16 solid insulated hookup wire to make the other connections.

Sockets SO1 and SO2 are conventional three-pin grounding-type AC receptacles. The grounding pin must be electrically connected to the aluminum case. Use a three-wire grounding-type power cord, and connect the ground lead (green) to a solder lug bolted to the heat sink.

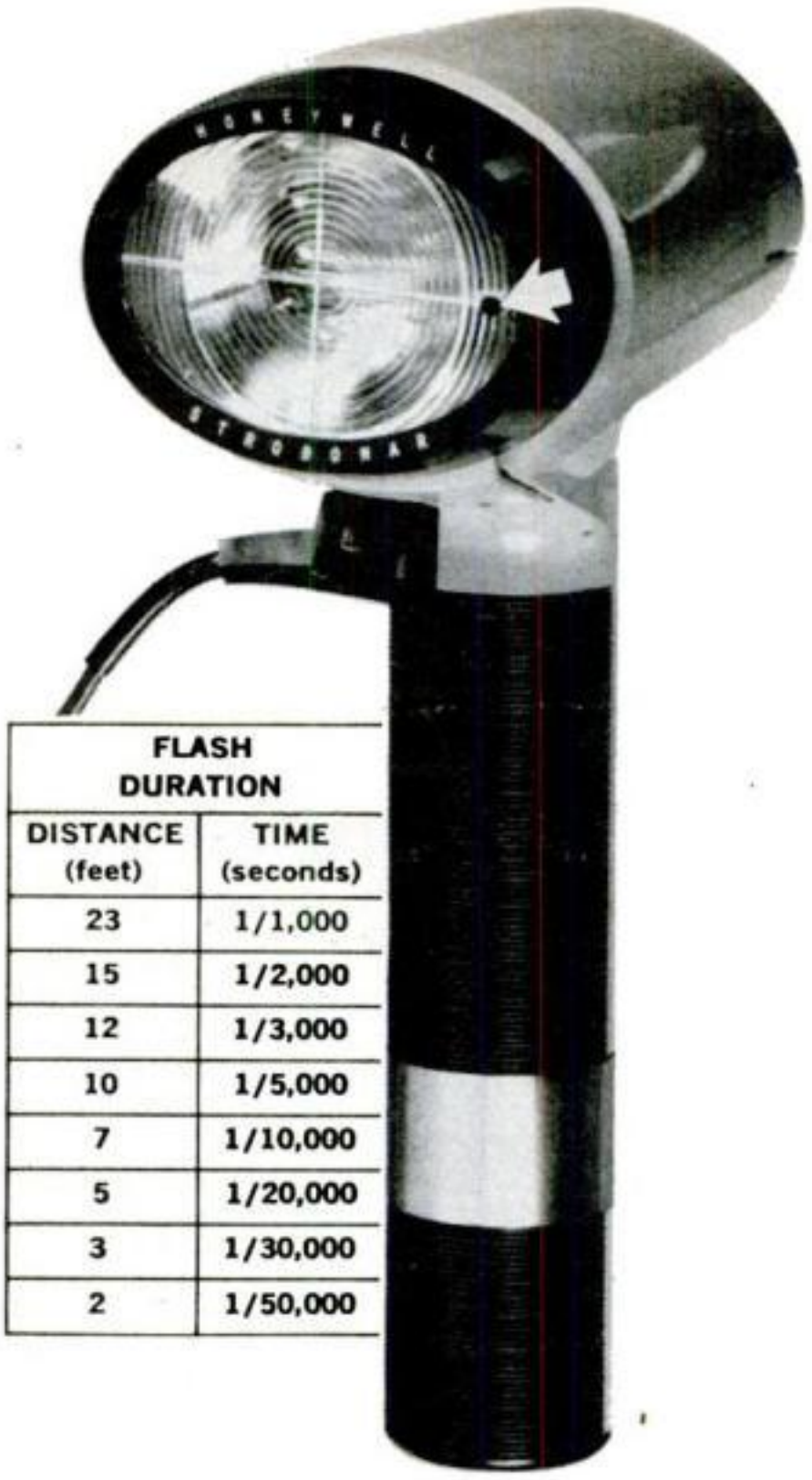
Be sure to limit the load power of each circuit to less than 600 watts. The controller will operate only on a 110-volt AC line —don't connect it to 220 volts AC—and will not vary the speed of an AC motor that does not have brushes. ■ ■

Urheberrechtlich geschütztes Material

what's new in PHOTOGRAPHY

No Guide Numbers—This Strobe Adjusts Its Light Output

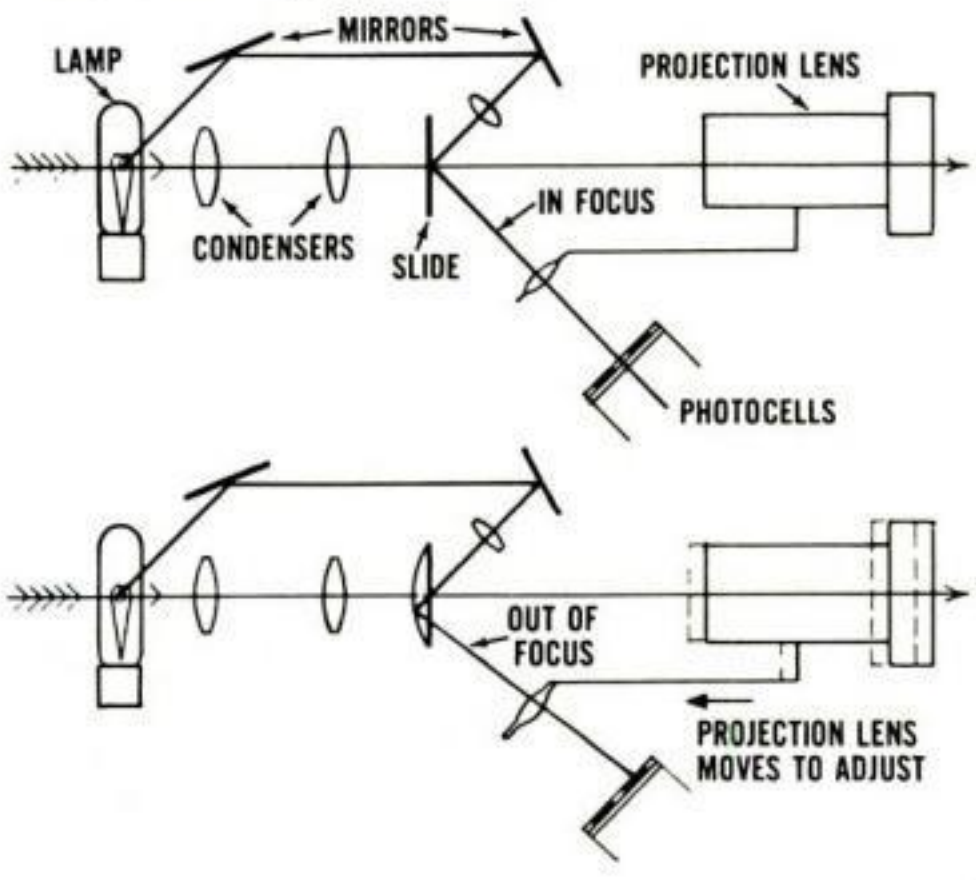
THAT little dot on the face of Honeywell's new Auto/Strobonar 660 works a miracle every time you take a flash picture: At the exact microsecond that the subject has received enough exposure, it tells the strobe to turn off. Obediently the strobe extinguishes itself by dumping its excess charge. The dot is actually a sensor—a CdS cell—that measures the light reflected back from the subject. If the subject is close—say, two feet—the sensor will tell the light to turn off after 1/50,000 second. At 23 feet—maximum range for automatic use—the unit will flash for a full 1/1,000 second. You never change the camera aperture, save to set it at the beginning of a roll of film; exposure is determined entirely by flash duration. The unit can also be used, with the flick of a switch, as a convential electronic flash. Cost: $129.50.



FLASH DURATION	
DISTANCE (feet)	TIME (seconds)
23	1/1,000
15	1/2,000
12	1/3,000
10	1/5,000
7	1/10,000
5	1/20,000
3	1/30,000
2	1/50,000

New rotary-tray projector adjusts automatically for slide pop

Honeywell's Rondelle 100 features a rotary tray, magnetic-gravity slide feed (magnetism pulls the slide up; gravity pulls it back), and automatic lens adjustment for slides that are "popped" out of focus. Through a series of mirrors, infrared light from the lamp is beamed at the slide. If the slide is out of focus, it bounces the beam through a photocell that automatically makes the lens refocus. Cost: $149.50.



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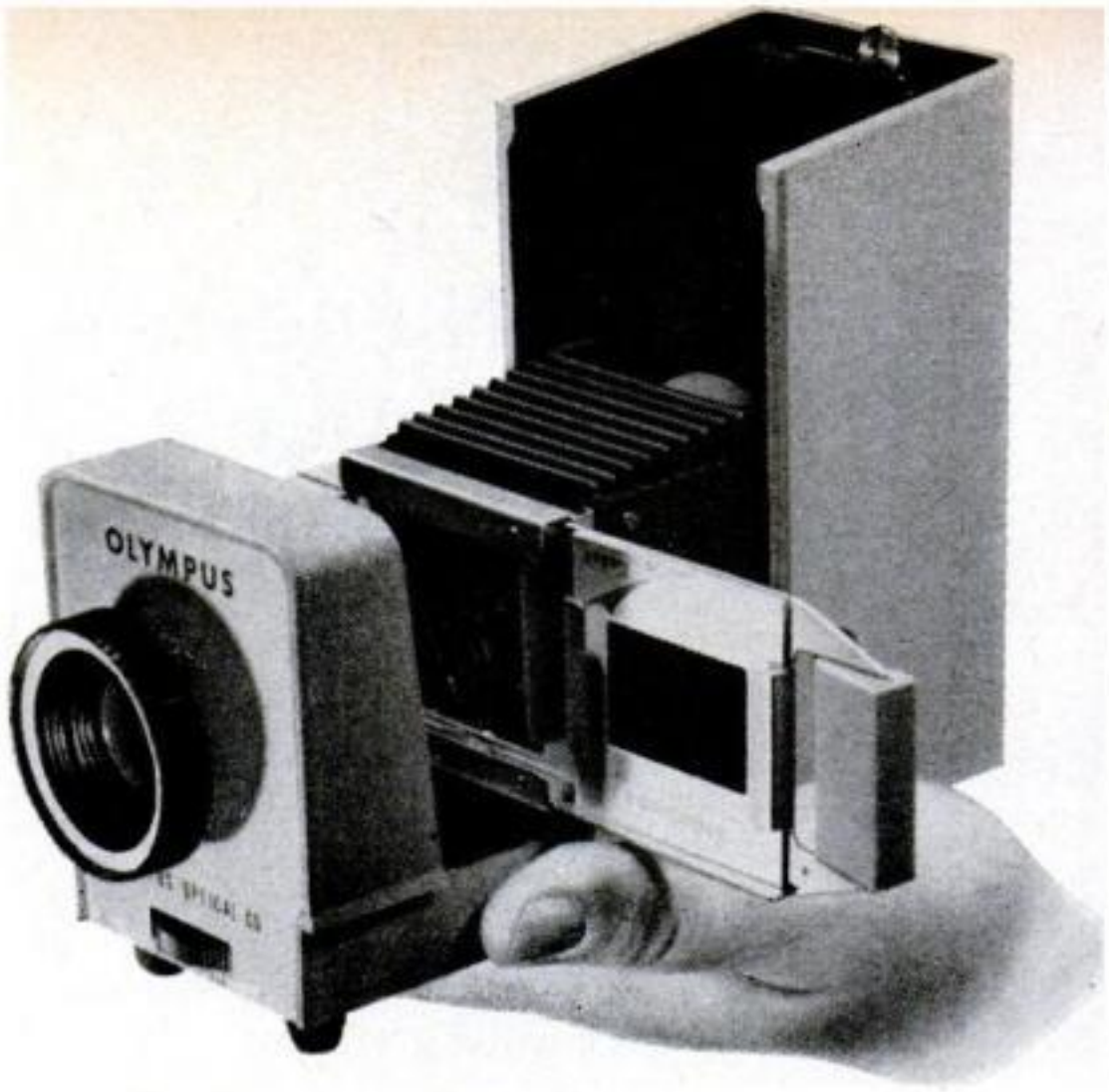
PS PHOTOGRAPHY

Take Your Slide Show with You



The new little projectors are high in quality, low in weight, and often come with their own carrying bags. And take a look at the new breed of viewers, too!

By Harry Walton

NOW featherweight projectors can put your slide show on the road. They're made to go places. Some come in sleek carrying cases. Sling one over a shoulder, and you're ready to show your slides just about everywhere.

No bigger than a desk phone—and lots lighter—these magic lanterns show big, brilliant pictures at short projection distances. You sit *with* your audience instead of a room's length away. And there's no noise—most of the new projectors have no blower.

Behind their surprisingly good pictures are better condenser systems and high-speed, short-focus lenses. These get more

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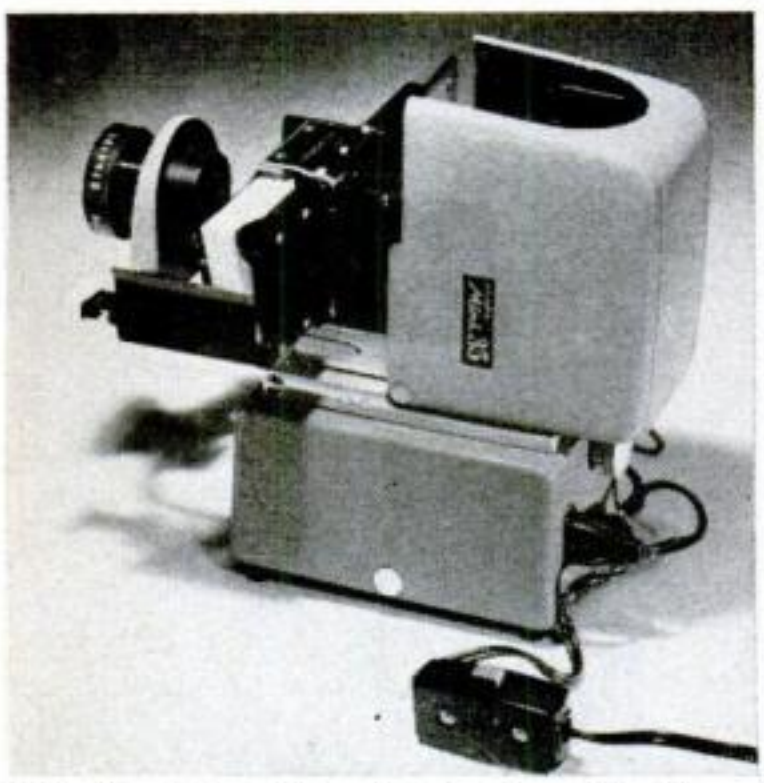


Minolta Mini-35 unfolds like this for use, comes in a vinyl carrying case at $37.50. Base shown adds a quiet blower and elevation control for $13 more.

Designed for half-frame transparencies, the Olympus Pen also shows full 35mm slides, blowing them up to 40-by-60 inches at a distance of eight feet. With case, the projector is $40. Blower base shown is $10.

Urheberrechtlich geschütztes Material

OLYMPUS PEN

HPI SOLO

BRAUN D10

MINOLTA

TRAV-L-AIRE

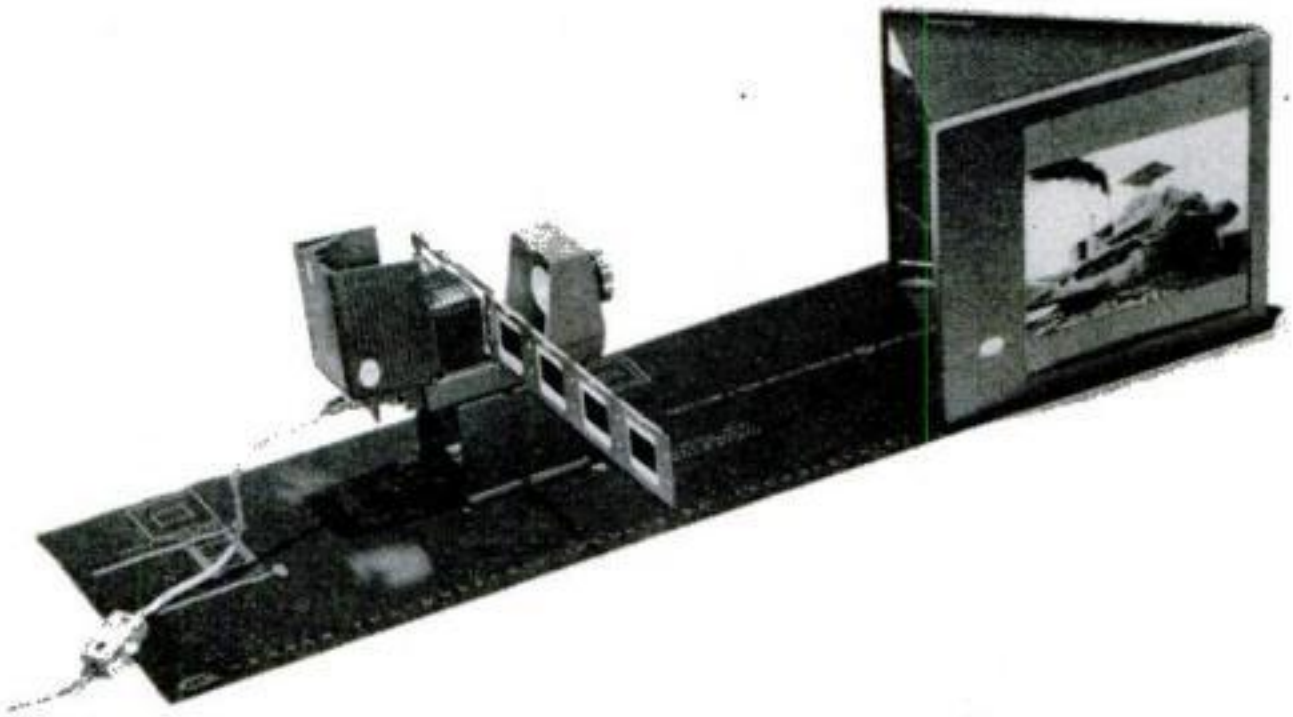
BALMITE 50

ALPEX

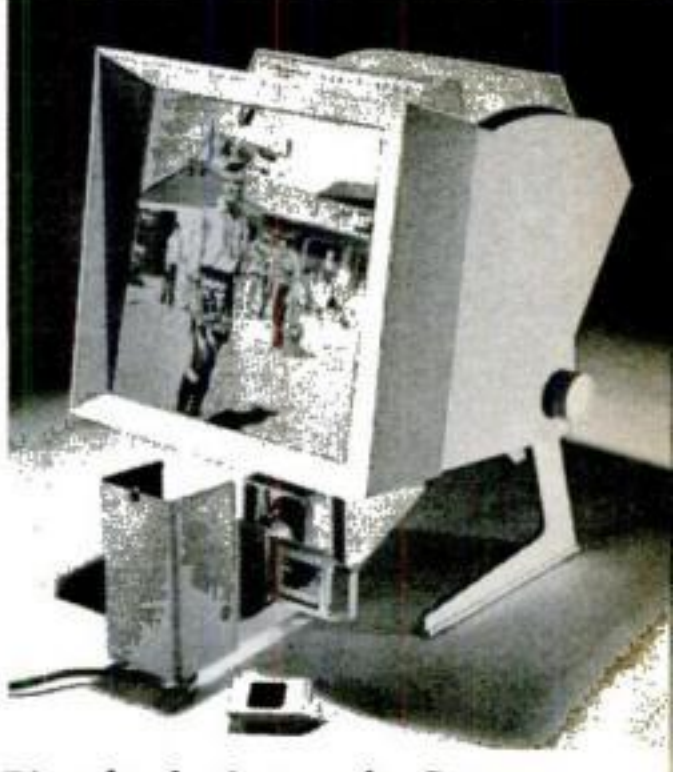
BRAUN COMBISCOPE

PRADIX

Smaller than ever, today's projectors display remarkable efficiency and some surprises. The elimination of a lamp house in some aids convection cooling, keeping slides safe from heat without the noise and expense of a blower. Some offer a choice of plain slide changers, or semiautomatic ones, and film-strip carriers. One (Trav-L-Aire) works on flashlight cells. Rear-projection screens (see the photo below) show pictures clearly in lighted rooms.



With right-angle projection on a translucent screen, the HPI Solo shows brilliant pictures in daylight. A marked felt strip helps in setting it up. The carrier holds six slides. Used in the usual way, the projector can fill a 40-inch screen.



Piggyback viewer, the Sawyer Mirascreen straddles your projector to give a TV-like picture that's nine inches square.

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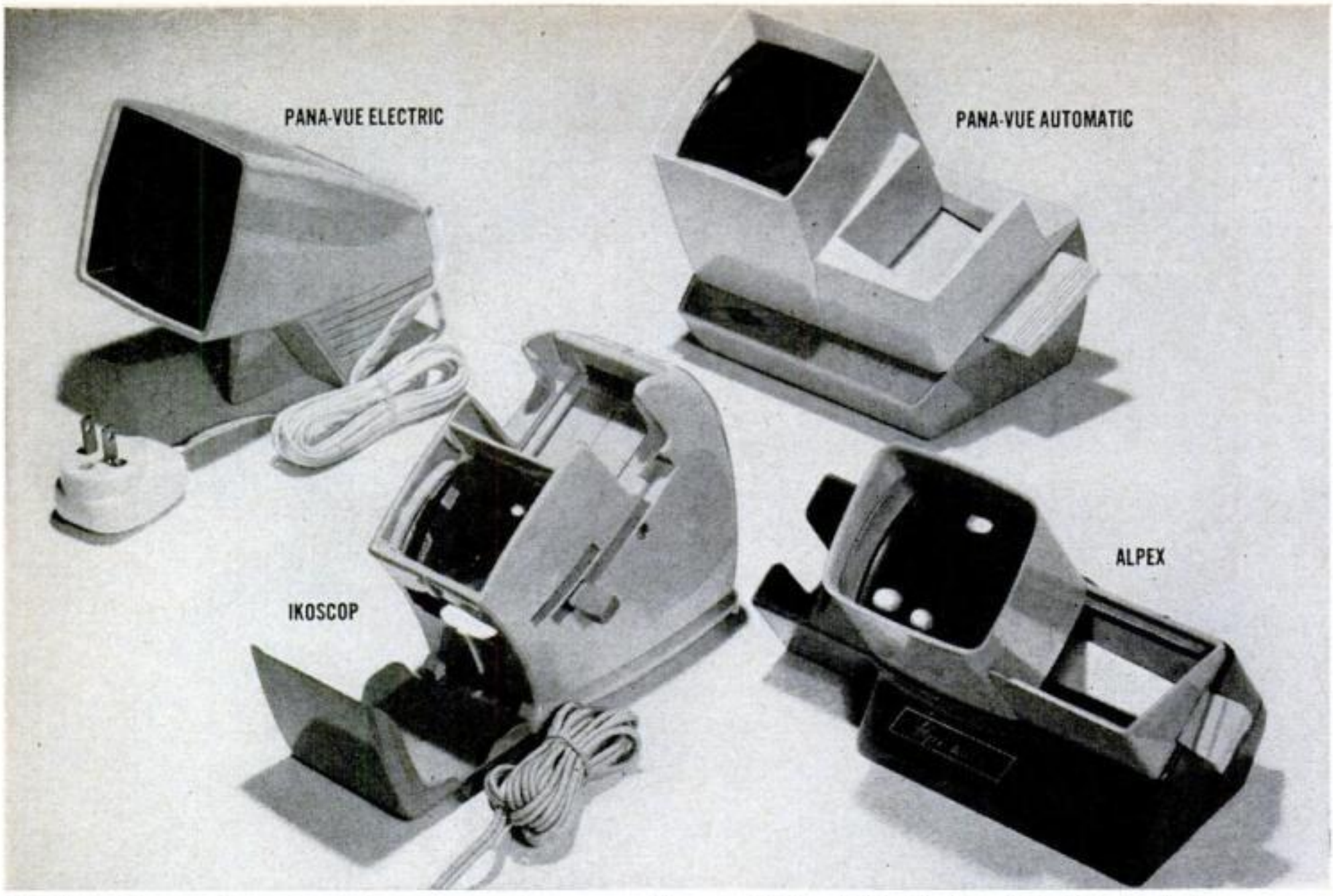

Modern viewers show sharp images over the entire picture area. Some have a push-pull action for changing slides. Pana-Vue Automatic and Alpex switch off the light while this is being done, prolonging battery life. Pana-Vue Electric works on either house current or two C cells.

light on the screen instead of dissipating it in long projection throws. There's also a trend toward eliminating lamp houses. Bulbs are more exposed, yet light spill is small. Clever baffling and blackened lamp ends do the trick.

Blowers, too. Slide heating is negligible, but if you like to keep your slides in view over long periods, low-priced blowers can be added to some projectors.

One of the most attractive of these is the Olympus Pen II. Made especially for half-frame (18-by-24mm) transparencies, it fills a 30-by-40-inch screen with these at eight feet.

It also shows 35mm slides. These burst on the screen—you'd need a five-footer at that eight-foot throw! They're sharp, with no color fringes or fuzzy corners. At shorter throws, they can be seen in room light.

Weighing less than two pounds, the Olympus comes with a 55mm, *f*/2.8 lens and carrying case at $40. An optional blower ($10) is built into a base; you just set the projector on it. A 40-slide changer and film-strip adapter are $11 each.

The Minolta Mini-35 is another handsome unit. Fold back the casing, slide out a lens mount, and you're ready for first-class pictures. The 75mm, *f*/2.5 lens fills a 36-inch screen at seven feet.

It also has a socket for tripod mounting. A blower base at $13 incorporates a tilt adjustment the projector lacks. For $10 you can add a 20-slide changer. Film-strip carriers are available.

Fine craftsmanship marks the Leitz Pradix, which offers a choice of *f*/2.8 lenses of 50, 85, and 100mm focal lengths. A 150-watt lamp system shows pictures even with room lights on. They are very sharp, with excellent color definition. The 85mm lens forms a 28-by-42-inch image at nine feet.

Priced at $51 to $68 depending on the lens chosen (the 85mm is cheapest) the Pradix offers as extras a fitted carrying case and a film-strip carrier. A screw socket permits tripod mounting.

Built for two jobs. The Braun Combiscope ($35) is both a viewer and projector. But the screened pictures are of only fair quality, with some color fringes. The lens, mounted on two rods, is awkward to focus,

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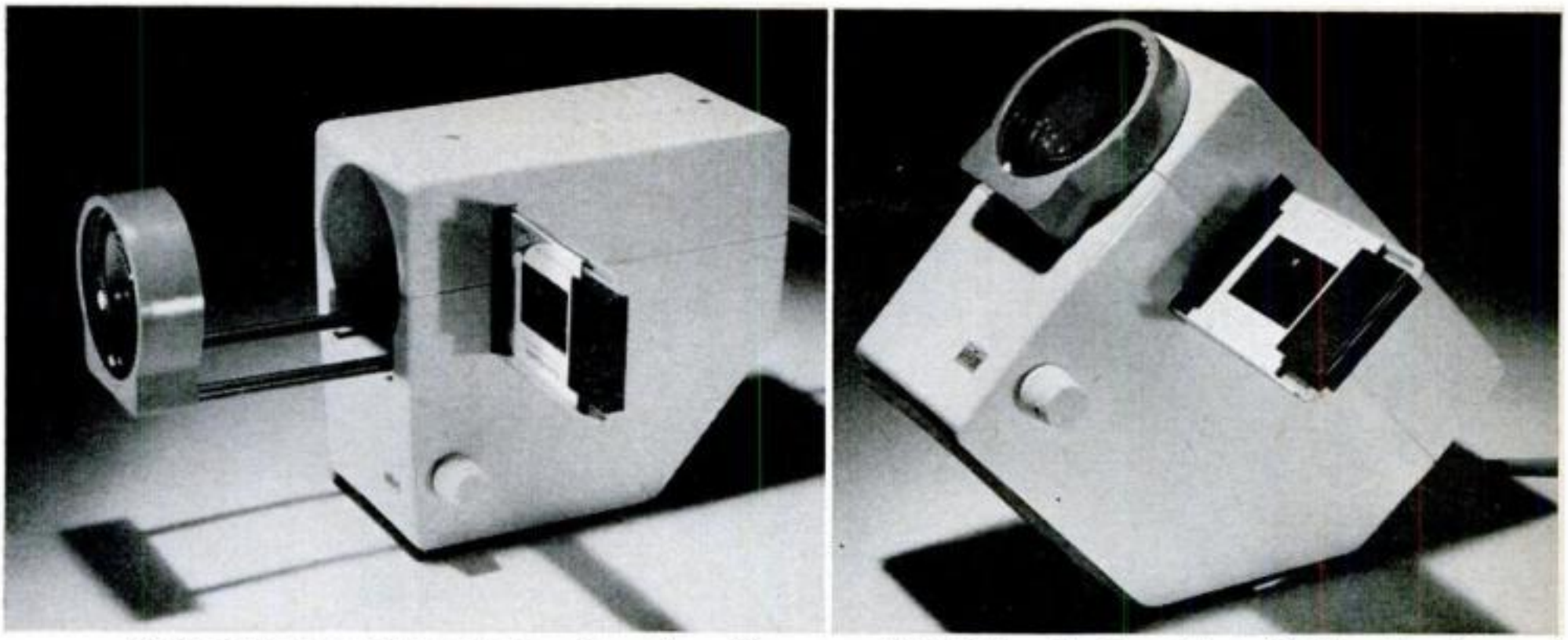


Both a viewer and a projector, the unique Braun Combiscope rests flat for showing screen pictures, as shown at left above, or tilts back (right photo) for viewing slides. Pulling the lens out for projection swings an opal viewing screen out of the way of the 25-watt bulb.

and a buit-in transformer makes the unit heavy.

The Braun D10 ($50) is a straight projector with a 150-watt lamp and a quiet built-in blower. Its 85mm lens throws brilliant pictures of medium size at short projection distances. Sharpness and color definition are good.

Bargain-priced at $23 in a shoulder case, the Alpex projects good pictures. In the sample tested, however, the slide carrier tended to stick. The Balmite 50, a $15 plug-in projector, gives good-size pictures in a dark room, though the edges are a bit fuzzy.

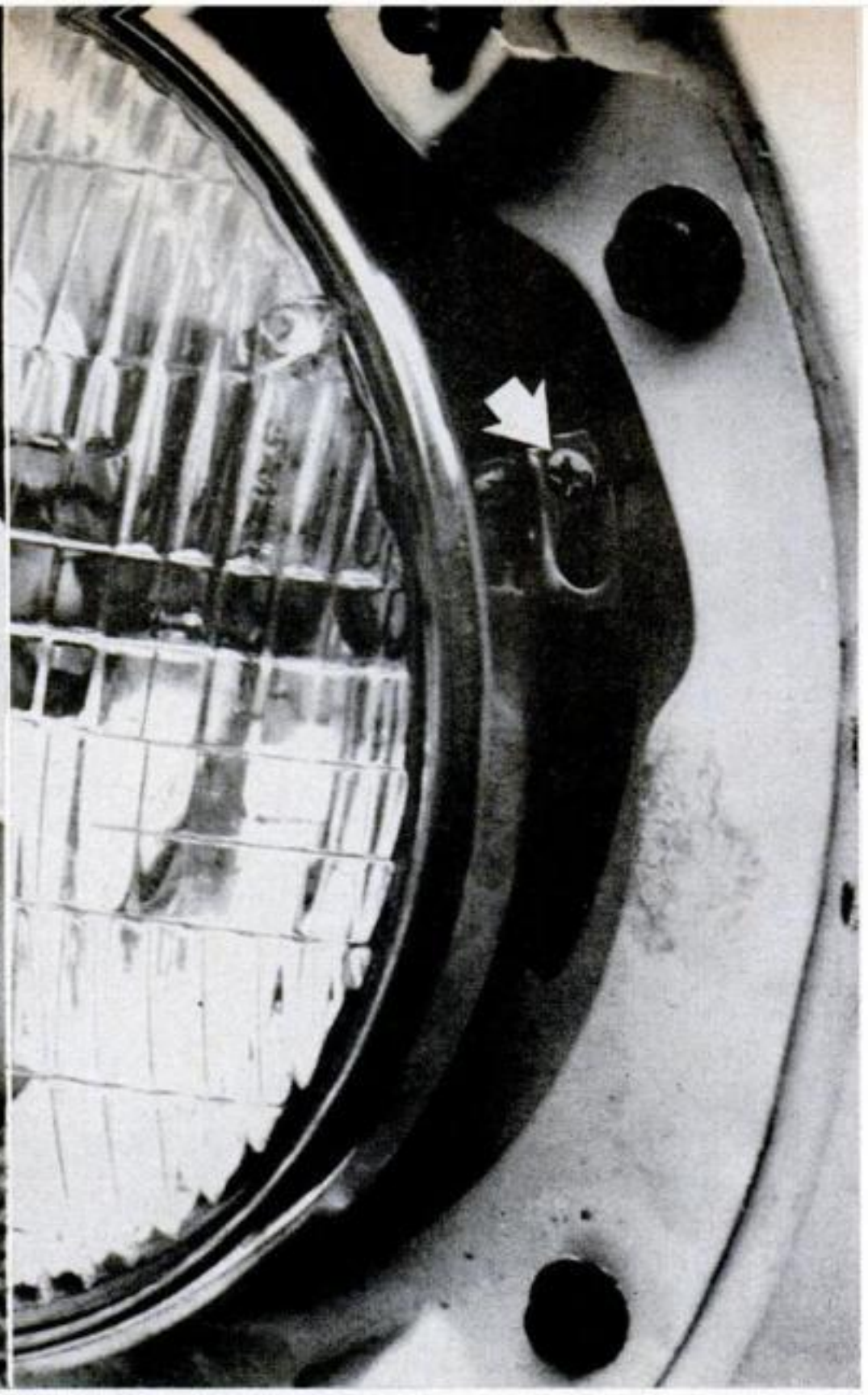
Need a battery-powered projector? Try the Trav-L-Aire (sold by Value Village, Buffalo, N.Y., for $8). Its 12-by-18-inch picture isn't of high quality, but it's adequate for editing, snatching a look at new slides, or letting the kids put on their own shows in perfect safety.

Rear projection next? The HPI Solo system has a compact projector and eight-inch-square folding screen with a front-surface mirror behind it. This combination shows bright, grainless pictures in lighted rooms. Rear projection in the Sawyer Mirascreen, made for use with any projector, also throws the picture onto a translucent screen. Once adjusted, it gives brilliant closeups—even in daylight. It's fine for editing or intimate viewing. About $30.

Viewers. Table-top viewers range from manual battery units to the ingenious motorized Argus Electromatic. Semiautomatic ones move a slide through viewing position to a discard stack at a finger flick. At least one, the Zeiss Ikoscop ($13), also takes film strips. ■■

Argus Electromatic viewer takes a stack of 36 slides. Flip on the motor, and a new picture moves into place every five seconds, propelled by a slowly rotating plastic finger (right). Turning a knob holds any slide for viewing as long as you like. Magnification is three diameters. The unit uses house current, and is priced under $20.

Dead sealed-beam unit is a snap to change, and usually you won't even have to re-aim the light. Start by removing the outer trim panel. One to four screws usually hold it in place.



Light sheet-metal ring around sealed-beam unit secures it. Loosen, but do not remove, the small Phillips screws (arrow) so metal ring can be turned enough to come off over screwheads.

Keep Your Lights

When your car lights go out, there are easy ways to spot the trouble—and make the fix

WOULD you know if your left headlight went out, turning your car into a dangerous "One-Eyed Dick"? Or if a stoplight were to short-circuit, could you fix it? These and other potentially dangerous, or merely annoying, troubles with your car lights are both easy and inexpensive to fix yourself.

First you need to know that something has gone wrong. Spot trouble by checking out your lights whenever you park your car in the dark. All you have to do is turn on your high and low beams when you are close enough to another car or your garage wall. A dead light will stand out. Check directional signals, parking lights, brake lights, and back-up lights the same way.

Sooner or later, your checks will turn up a dead bulb or some other lighting malfunction. Mostly it's a burned-out bulb which is simple to replace. If you've been forehanded, you'll have the spare bulb you

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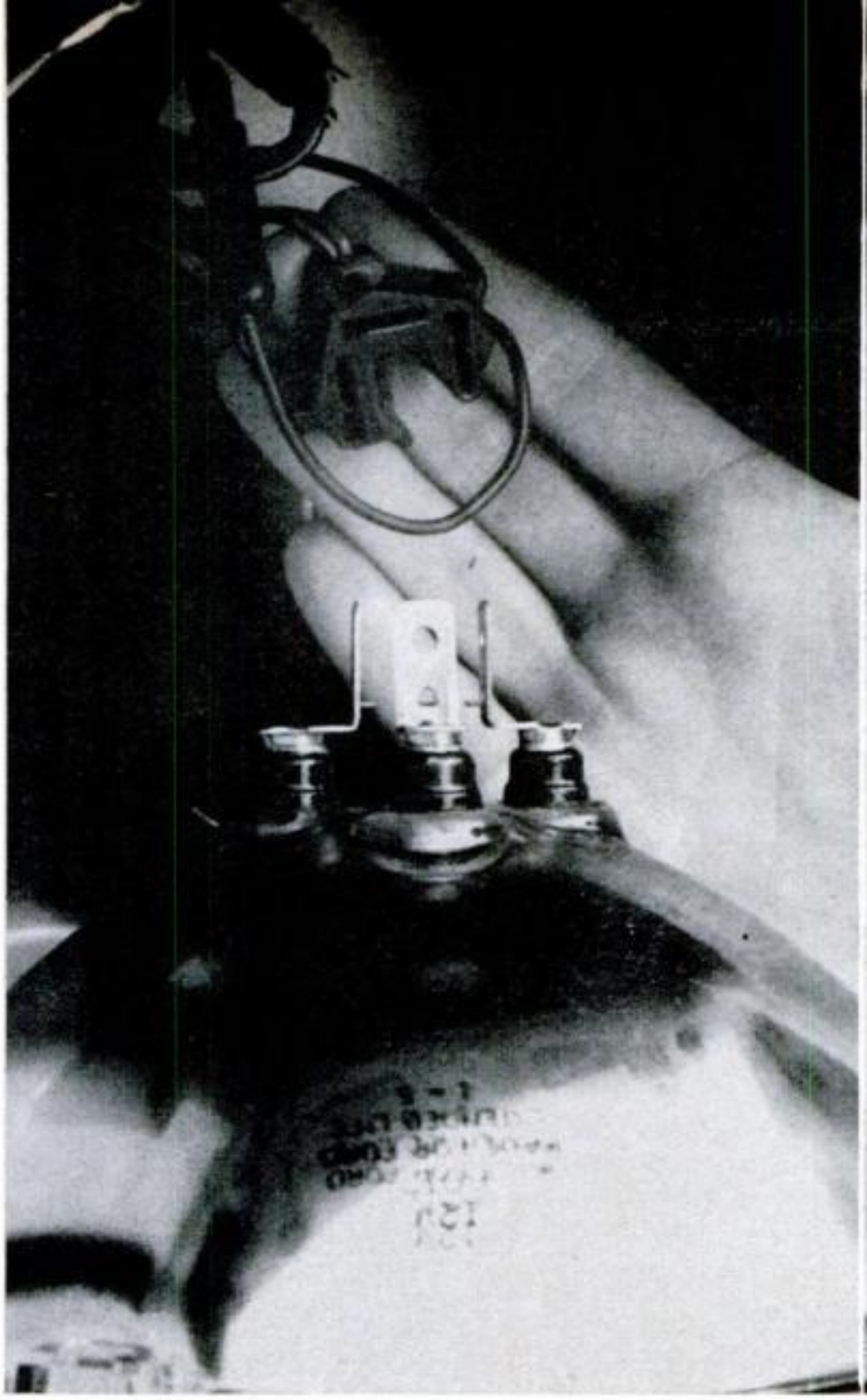
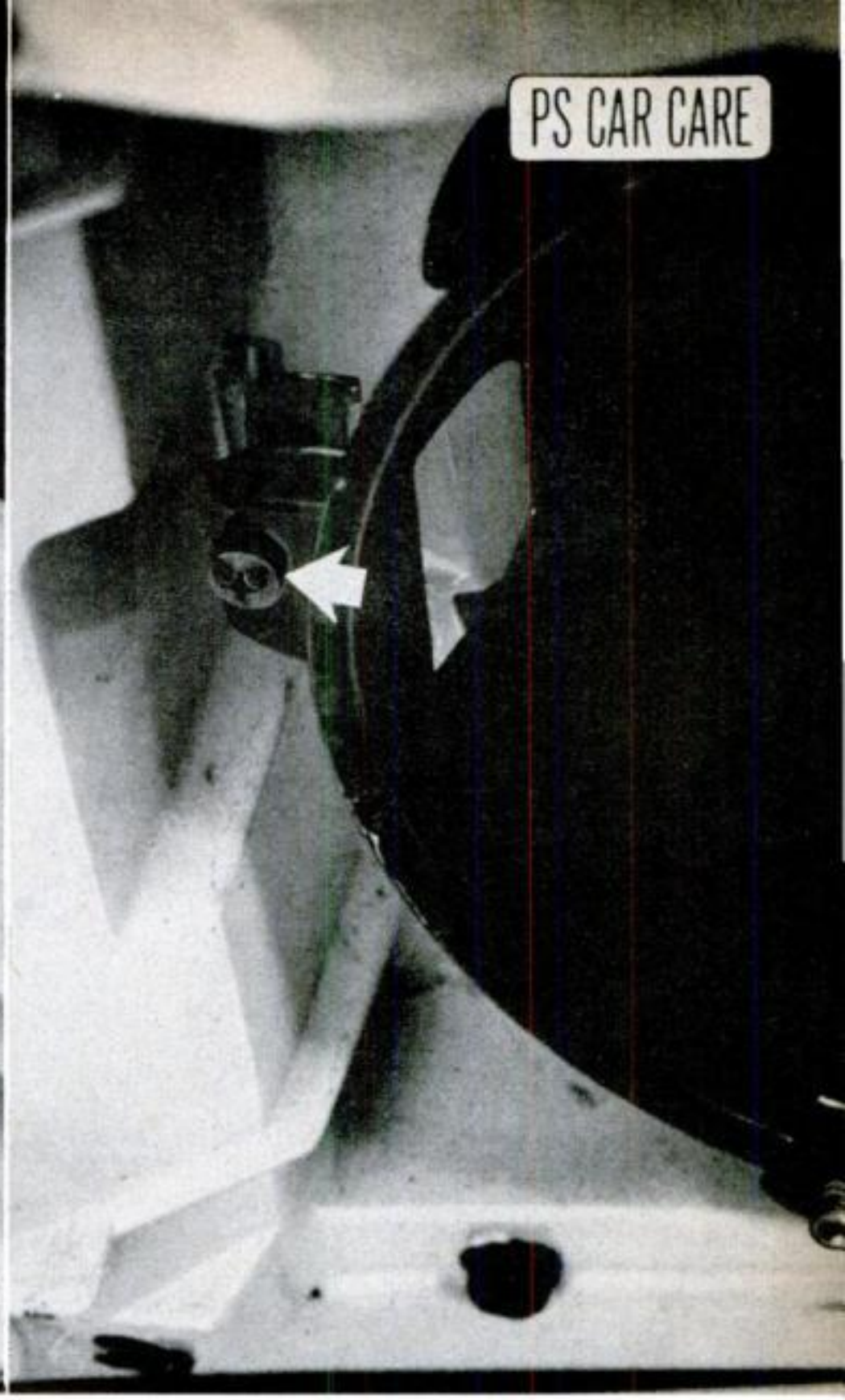


Unplug sealed beam from connector to replace it. New one should be the same type (and preferably the same brand) as its mate. Save yourself risk and trouble by replacing both lights.



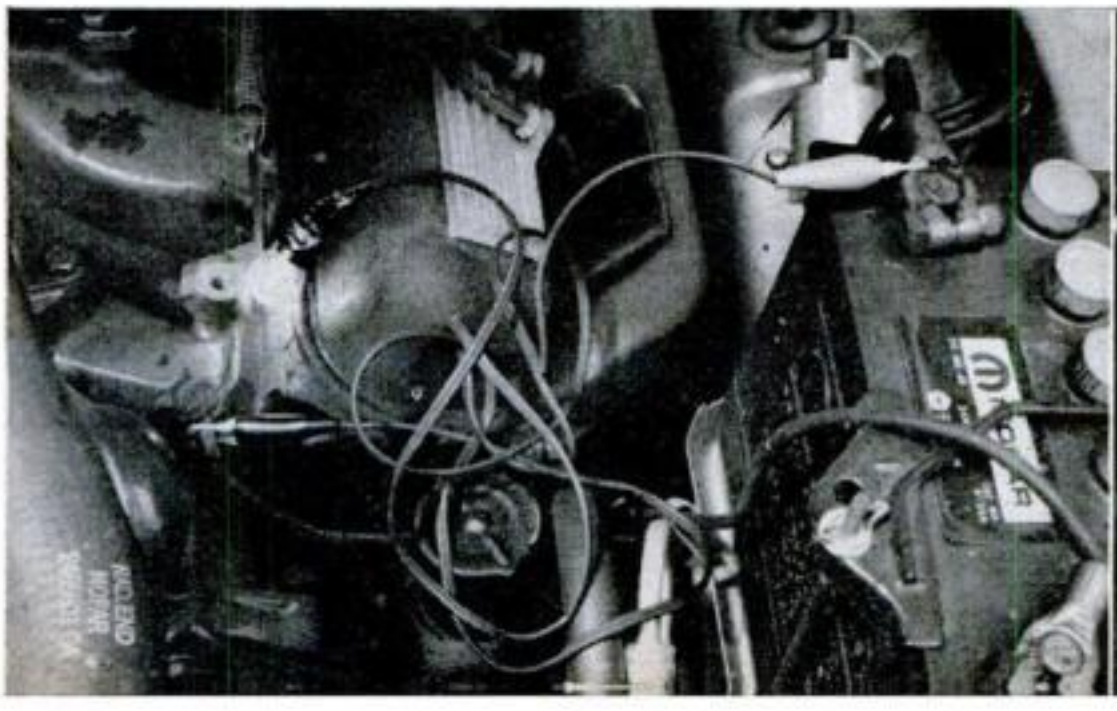
Light-aiming screw (arrow) need not be touched when changing sealed beams. Light-aiming calls for a $15 to $50 aiming gauge. Service stations charge a dollar or so to do the job for you.

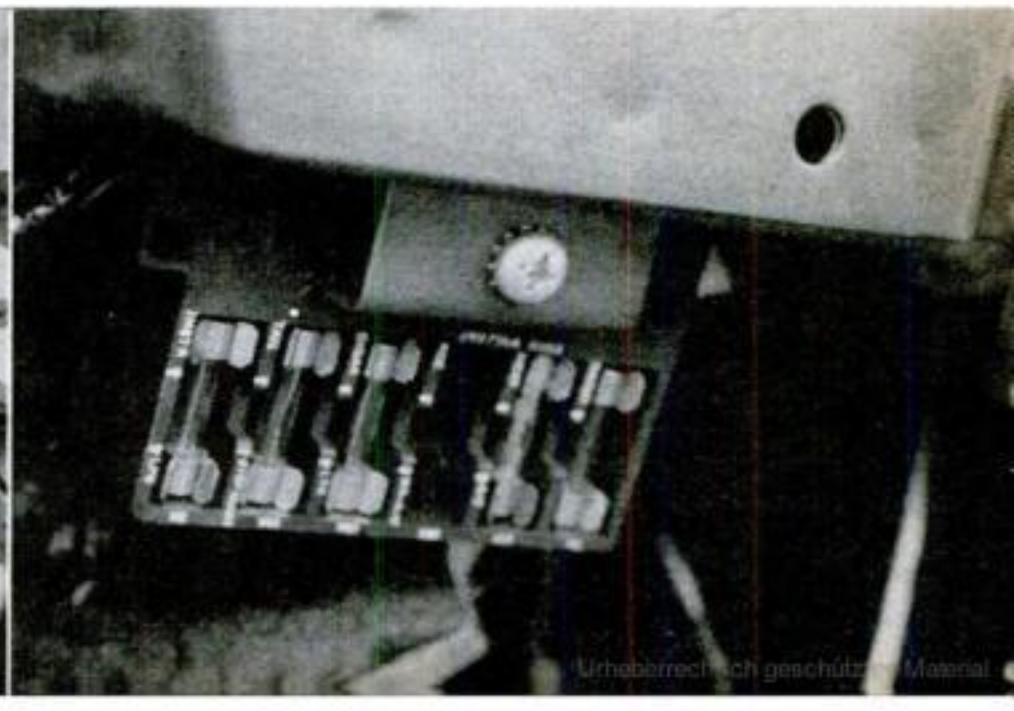
Beaming

By Angus Laidlaw

Primary tool for home auto electrician is test light like the one shown below attached to battery. Make one from a burned-out two-filament tail-light bulb, wire, and two alligator clips.

Fuse box, often hidden under the dash, is the next place for you to check, if a new bulb does not fix the dead light. It's always a good idea to carry spare fuses in your car.





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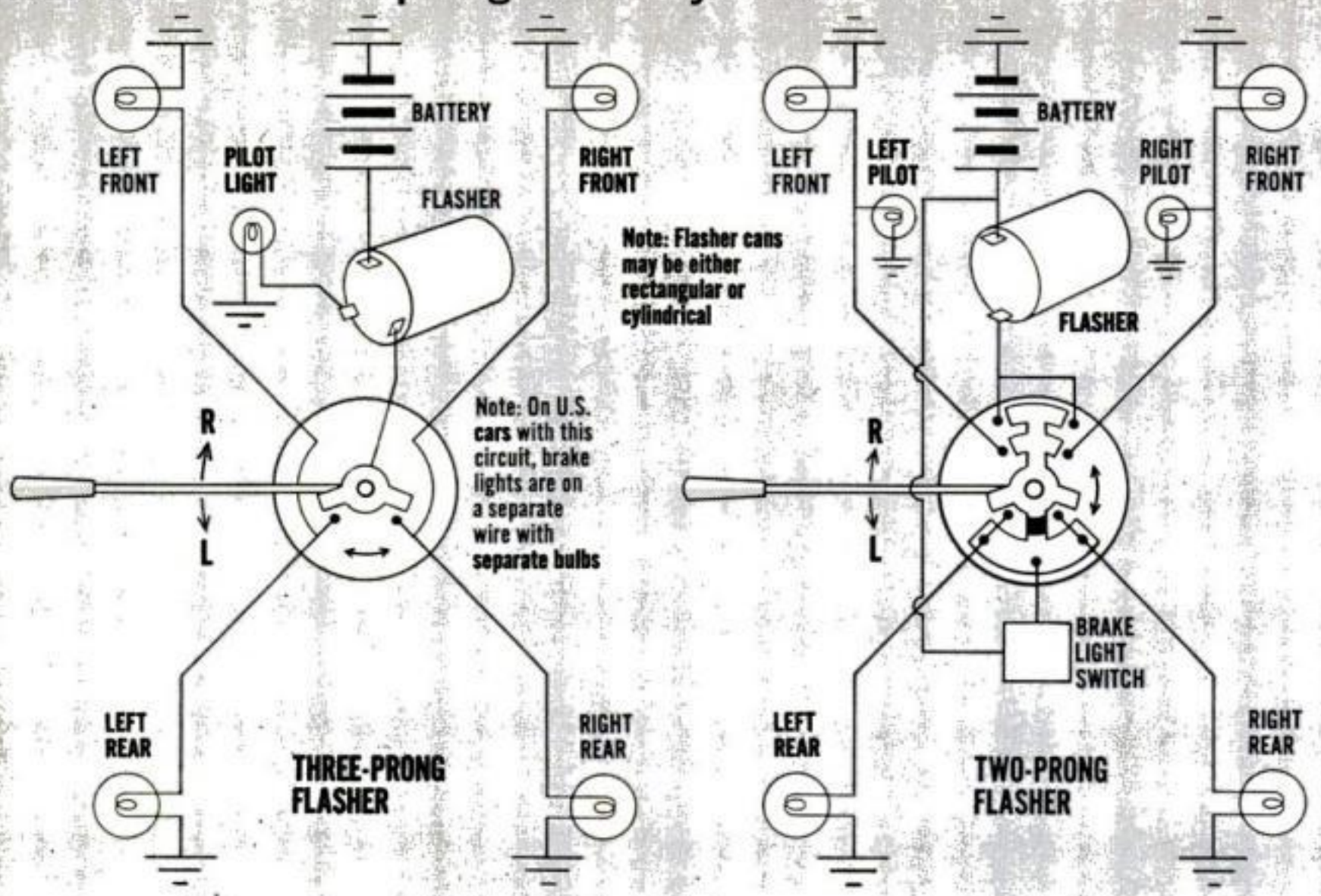

Old-fashioned three-prong directional-flasher wiring circuit looks like this. When a bulb goes, pilot light will possibly flash once and then go out; remaining signal flashes faster.

Modern, two-prong flasher hookup is simpler, cheaper, and more reliable than the three-prong type. Positive warning for a dead bulb is a steadily burning pilot light with no flash.

need in your glove compartment, unless it's a sealed-beam headlight unit which is a bit awkward to carry in the car because it's so big.

Be sure that the replacement bulb is of the same type and carries the same number as the dead one. Photos show how to get to most common types of bulb sockets to make replacements.

If putting in a new bulb doesn't cure the trouble, check the fuse (or circuit breaker). Your usual clue here is that several lights or other electrical items suddenly went out at the same time. (But check the bulbs first, anyway; two tail-light bulbs often burn out simultaneously, making bulb trouble look like circuit trouble.)

Most owners' manuals will tell you where the fuses are, so check these next. For a full wiring diagram, you'll probably have to turn to the more-detailed service manual. If your car is an import, the owner's manual is usually more helpful about do-it-yourself information.

If replacing the fuse doesn't cure your trouble, or if the fuse blows again after you've replaced it, you need that wiring diagram. Don't let it throw you when you first look at it. Each circuit is basically a wire leading from the battery to the fuse to the switch to the light and back to ground to complete the circuit.

Trouble shooting. A test light built into a jumper wire comes in handy for following the circuit in the car. The cheapest way to make one is to solder two wires to a tail-light bulb (an old one with the stoplight filament burned out is okay), and attach alligator clips to the ends of the wires. Check circuits by hooking your test light first across the battery and then by hooking it up from each connection to ground to see if current is getting that far. With your light turned on, this is a good way to spot broken or grounded wires where insulation may have worn through or cracked.

If your directional signals act up, the trouble is almost always a dead bulb. It is particularly important to replace each bulb with one just like it. Heavy-duty bulbs won't work right in a circuit with a flasher intended for standard bulbs. Light-duty

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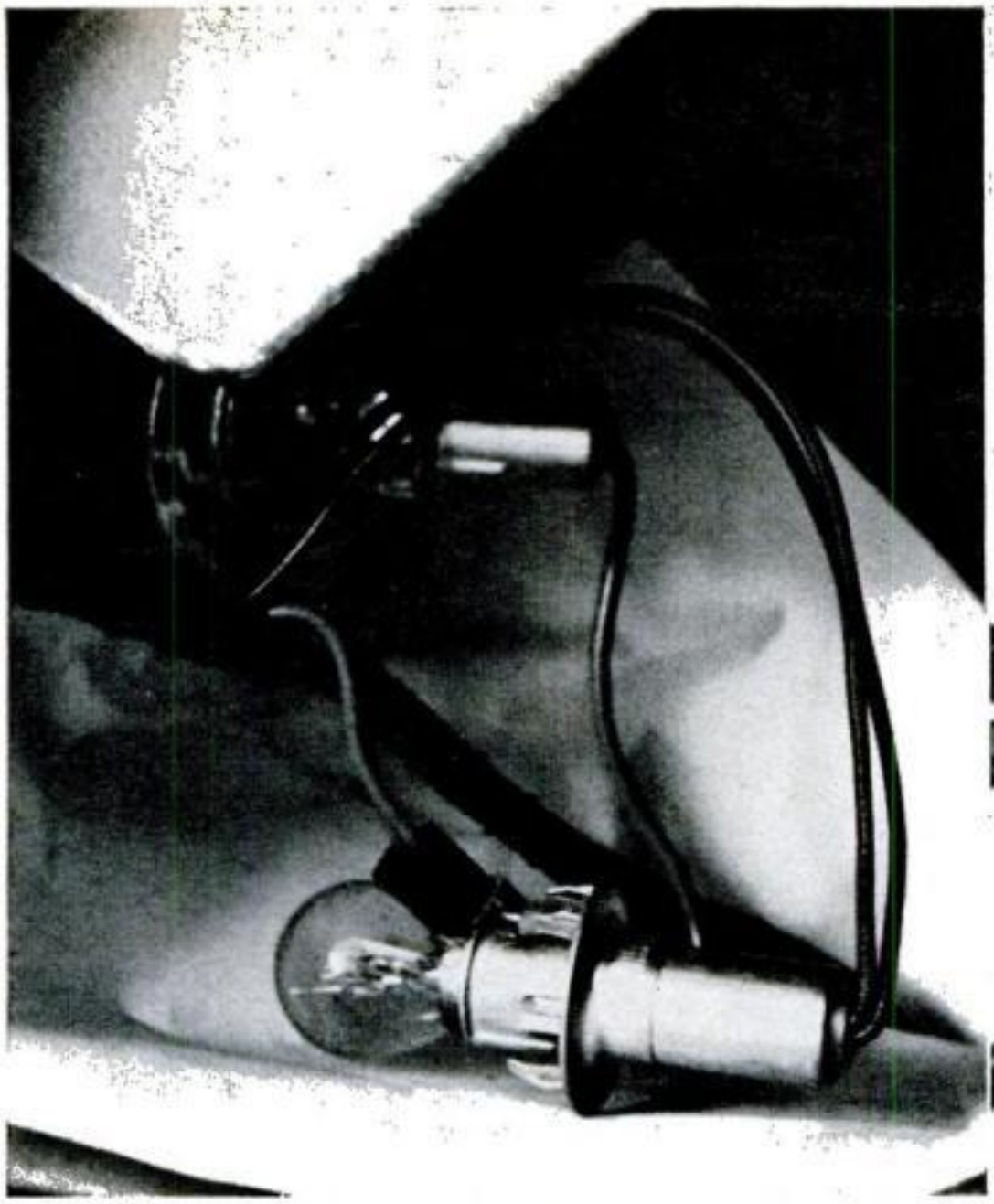
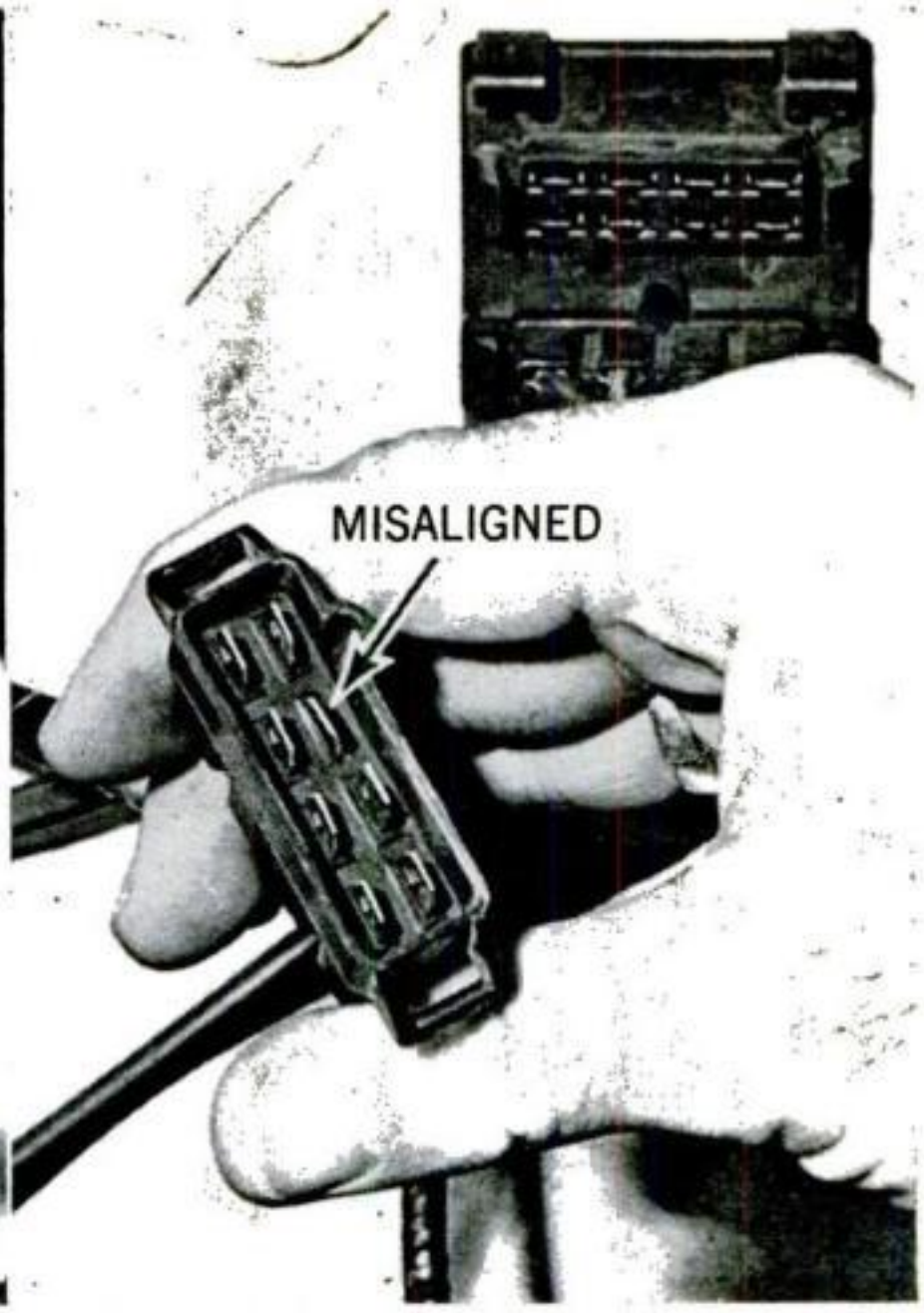


Tail lights, directional signals, and parking lights can be reached in two ways. In many cases you must unplug the bulb holder from the inside to get at a dead bulb for replacement.



Prongs bent out of alignment and corrosion can knock out handy new multiplug connectors. Check for current by clipping leads on test light to first one side and then the other.

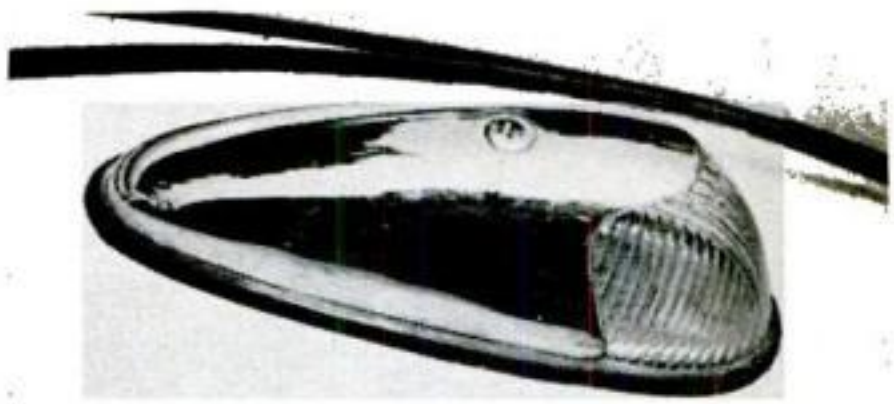
bulbs with a heavy-duty flasher also give trouble. Standard bulbs with a heavy-duty flasher will give slow flashing rates, new heavy-duty bulbs with a standard flasher flash more rapidly.

Directional-signal troubles. The first check to make when you suspect directional-signal trouble is to try the signals for the other direction. If they are okay, then the flasher and everything except the wiring and bulbs on the bad side is all right. Check the bulbs, wiring, and light sockets for corrosion and a good ground. Your test light makes this quicker and easier.

If the pilot light comes on steady, then you know your two-prong flasher system has a bulb out. If the pilot light goes out in a two-prong system, then you know the pilot light itself has burned out.

Usually, lighting troubles are burned-out bulbs, and the cure is to replace the bulb with one of the correct type.

If a sealed-beam headlight has burned out, you can replace it by following the photo sequence, and chances are you will not even have to re-aim the replacement.



Parking and tail lights often don't have inside bulb holders. These come apart with a screwdriver so that you can reach the bulb to replace it, and the bulb socket to check for current.

Try to replace it with the same type and brand as the old one. Save yourself future trouble by replacing its mate on the other side of the car at the same time. Headlight aiming is worth having done by a properly equipped service station since they can do it to comply with state laws.

Whether you do it yourself or have it done, keeping all your car lights beaming is a big safety factor for winter's increased night driving. And don't forget: You can brighten your lights by just keeping the lenses clean. ■■

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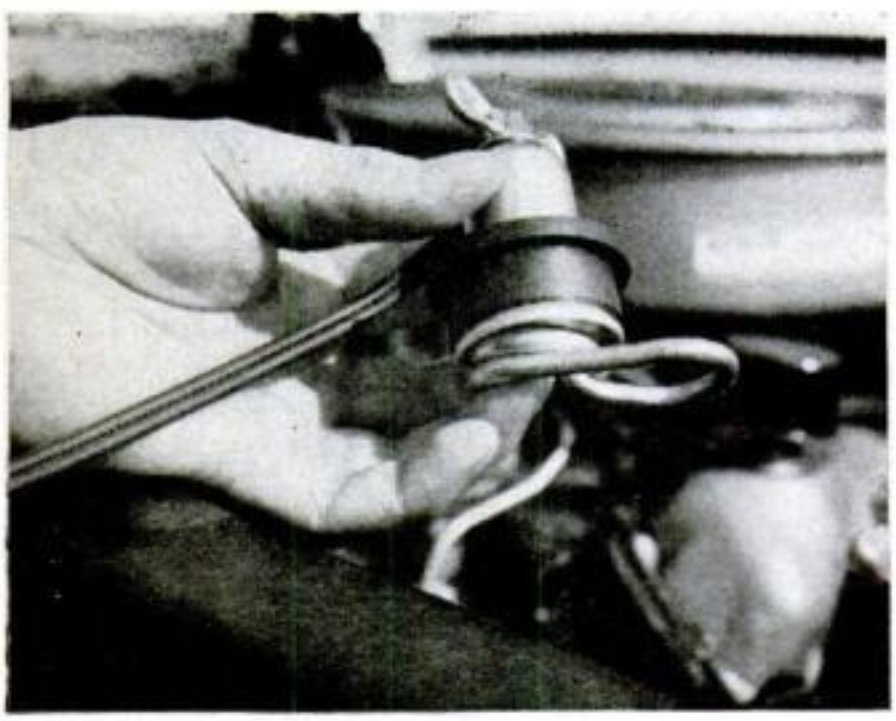
what's new for your CAR

Three-gauge clusters for dashboard mounting

With this three-gauge housing, you get your choice of instruments: Pick a tach, amp and oil-pressure gauges; or substitute a water-temperature gauge for the tach. Rite Autotronics Corp., 5221 W. Jefferson, Los Angeles, says installation is simple.

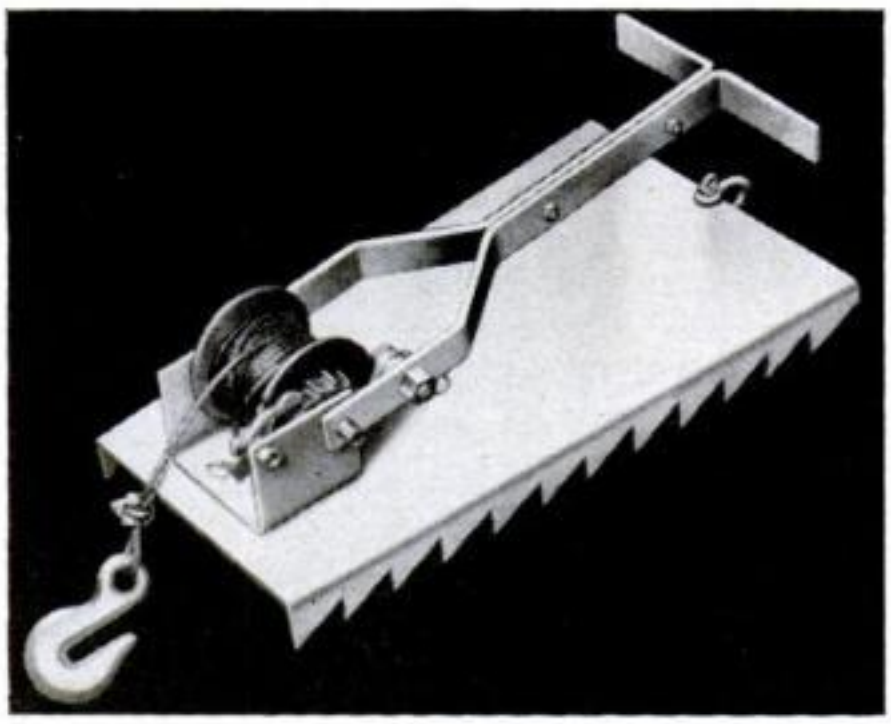
Twin-wing mirror gives a wider view

On modern multi-lane highways it's necessary to know what's behind you in all lanes. Here's a twin-wing mirror with a view of the lanes to right and left of your car. The mirrors are swivel-mounted in a Cycolac base that sticks to dashboard or windshield. Freeway Plastic Products, 1826 Norwood, Grosse Pointe, Mich., sells it for $5.95.



New engine heater fits in core-plug hole

A simple way to avoid cold starting is to keep the coolant warm. From the Master Specialty Co., Savage, Minn., you can get a 110-volt AC-DC heater that fits in the core-plug holes of all popular cars. To install it: drain cooling system, remove core plug, insert self-expanding heater.



Tow your own car with portable winch

Winter gives most of us many opportunities to get stuck, and here's a winch to get your car mobile again. The handle works a 30:1 double ratchet while the traction plate holds the winch in place. With 25-foot cable, $29.95 from Hobi, 37-19C Lawrence St, Flushing, N.Y. 11352.

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SHOP TALK

By Robert P. Stevenson

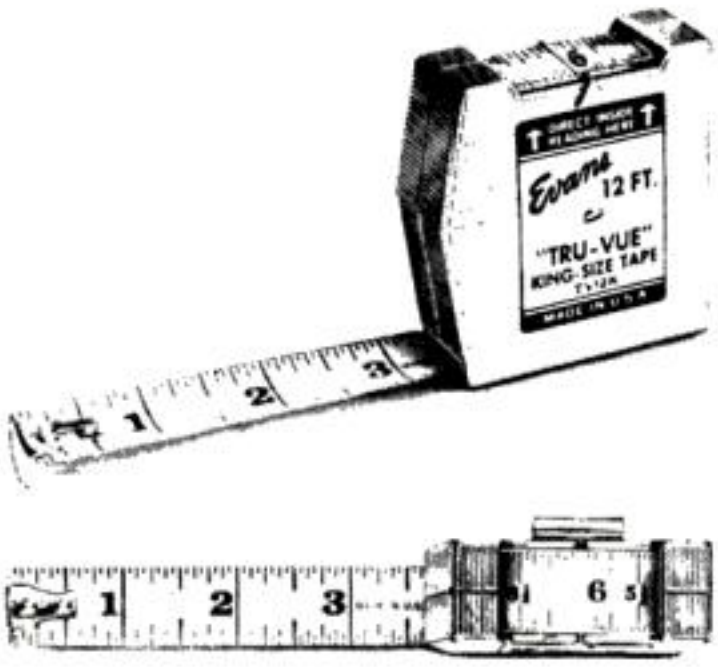
How to end the hazard of clipped wire flying from plier jaws

You know what happens when you clip off a piece of fine wire. It goes flying—and it *could* hit your eye, or your neighbor's. Some days ago we heard about a pair of wire clippers that solve this problem. Inside the jaws are do-it-yourself silicone rubber pads that grip the piece of cut wire. Two specialists at GE's Radio Guidance Operation in Utica, N.Y., developed the idea. Clean the jaws and bind them shut with rubber bands. Put GE Silicone Bathtub Seal (available in tubes at hardware stores) in the jaw depression and let cure for 24 hours. Then slice through the jaws with a razor blade. A pad of white rubber will remain inside each jaw.

Points about tacks—some useful, some not

A news release from Hillwood Mfg. Co., Cleveland, a major tack maker, gives us some tack facts. Tacks come as long as 1⅛", as short as about 3/16". You buy 'em by number: No. 1, smallest; No. 24, longest. Noting some tacks are blue because they've been heated for sterilization, the release adds: "Upholsterers and carpet layers hold tacks in their mouth. Consequently . . . a tack . . . must be sterile and taste right. An experienced tacker can tell . . . a different brand by the taste."

New tools and other products seen here and there at the hardware stores



Now you can patch leaky gutters or downspouts with a new aluminum-foil pressure-sensitive tape. Two major makers—Johns-Manville and 3M—have both recently announced it . . . If you use a new tape measure from Evans Rule Co., Elizabeth, N.J., you get a direct reading through a magnifying window (see photos) when you take an inside measurement . . . Walter E. Selck and Co., Chicago, has a new trowel system—one handle for 22 different blades. All blades are available to suit left-handed workers, too . . . Ridge Tool, Elyria, Ohio, offers an inexpensive ($5.95) screwdriving attachment for electric drills. Called Versamate, the speedy reducer comes with a slotted screw bit. You can also buy Phillips bits and a bolt-tightening socket.

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PS TOOLS

Here's how to team up a surplus aircraft generator and air-cooled gas engine to—

Make Your Own Arc Welder

Use the welder to make its own carrier by mounting the engine and generator temporarily on a heavy plank. Make the frame from ¾" pipe and 1¼" angle iron, dimensioning it to fit the generator and engine that you use. The engine

By John Burroughs

IF YOU'D like to own an arc welder, take a look at a surplus dealer's mail-order catalogue offering bargain-priced government-surplus aircraft generators.

Leading firms list more than a dozen models of DC generators. All are quality-built units with heavy-duty sealed ball bearings and heat-resistant glass-insulated windings. All are in good-as-new condition, and the price is right. Each generator cost Uncle Sam some $300. You can buy one for from $15 to $30, plus freight charge.

Any generator that can put out at least 75 amps of current at 25-30 volts DC will make a fine shop welder.

Though aircraft generators, which are shunt-wound, haven't exactly the same electrical characteristics as DC generators designed for welding, they perform surprisingly well. You'll have no difficulty striking and maintaining a stable, easy-to-handle arc. You'll be able to lay smooth beads of weld metal the first time you try. More, your welder will also braze and arc-cut.

How large a welder? Decide how much amperage you'll need for the kind of welding you'll do—before ordering a generator.

The current required to arc-weld with a mild-steel electrode is roughly equal to the electrode's diameter expressed as a decimal. Welding with ⅛" (.125") electrodes takes approximately 125 amps. Welding with ¼" (.250") electrodes takes about 250 amps.

While it would be possible to build a large welder from a high-amperage aircraft generator, you would encounter two problems:

- You'd find it difficult to reduce the big

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BICYCLE HANDLEBAR GRIPS
GAS TANK
AIR-COOLED ENGINE (MIN. 6 HP.)
REACTANCE COIL
WELDER TERMINALS
SURPLUS AIRCRAFT GENERATOR
20"
8"-DIA. WHEELS ON WELDED-ON STUB AXLES
B-WIDTH V BELT
¾" PIPE
TO SUIT ENGINE, GENERATOR

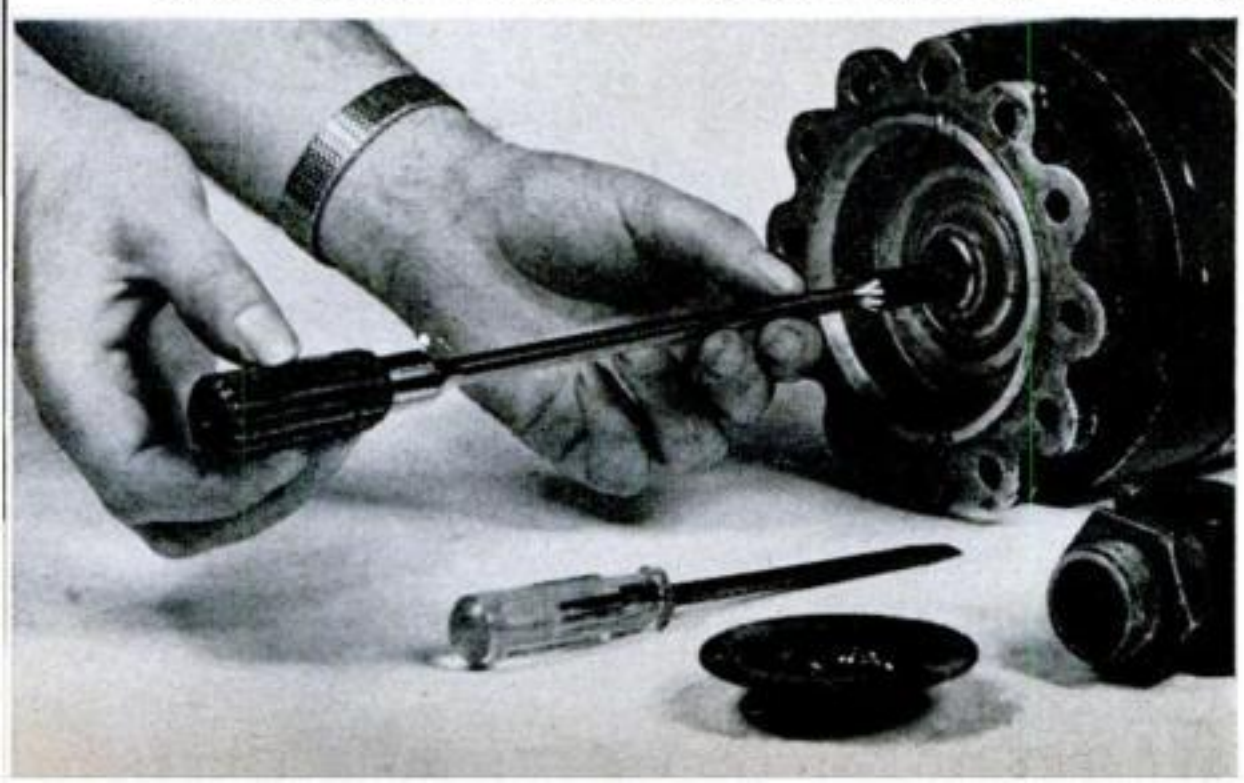
need not be new. In most areas you can find serviceable one-lungers in the secondhand market at reasonable prices. The author paid only $32 for the six-horsepower engine used in the rig in the photo above. Enlarge the frame as required if you decide to use a nine- or 12-horsepower engine to drive the generator that you decide to buy from the surplus market.

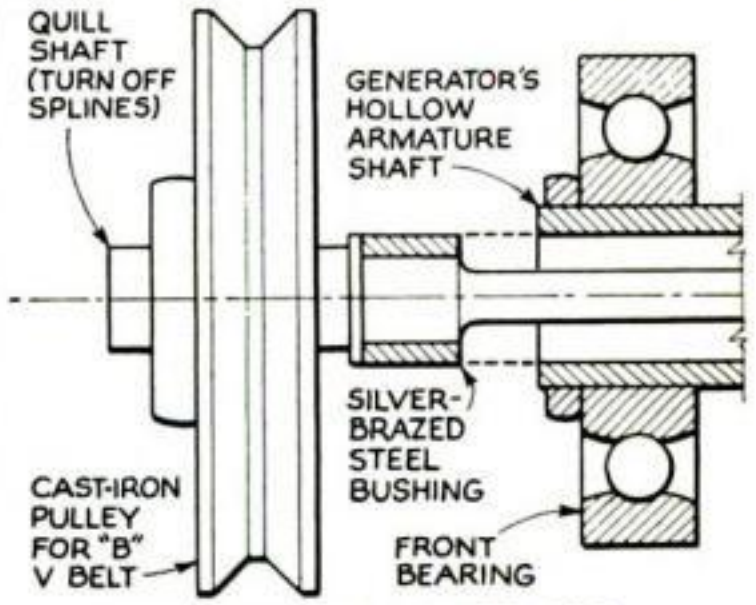
generator's output to the low amperage needed for light welding with small-diameter electrodes. Your welder, therefore, would be suitable for heavy work only.

You'd need a formidable power source to drive the generator, for generating high amperage imposes a heavy mechanical load. It takes a 35-hp. or larger gas engine to

CONTINUED

A spring-tempered quill shaft splined at each end drives an aircraft generator. Extending through the generator's hollow armature shaft, the quill functions as a torsion bar to relieve mechanical shock of a sudden heavy load. A smaller spline engages the armature at the commutator end. The large spline originally fitted into the gearbox for the generator. Diagram below shows how a pulley can be mounted directly on the quill shaft if the quill is built up with a brazed-on bushing for a press-fit into the generator's front bearing assembly—a simple metal-lathe job.




QUILL SHAFT (TURN OFF SPLINES)
GENERATOR'S HOLLOW ARMATURE SHAFT
SILVER-BRAZED STEEL BUSHING
CAST-IRON PULLEY FOR "B" V BELT
FRONT BEARING
DRIVE FOR SMALL GENERATOR

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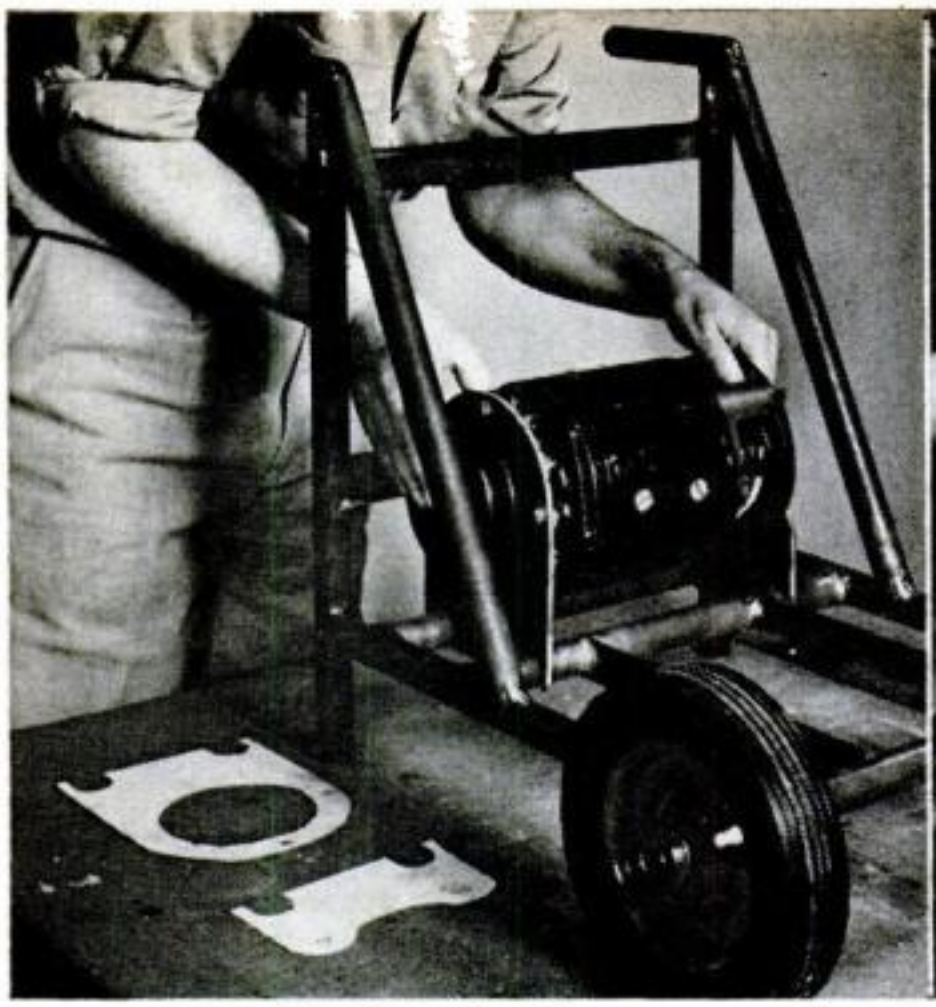
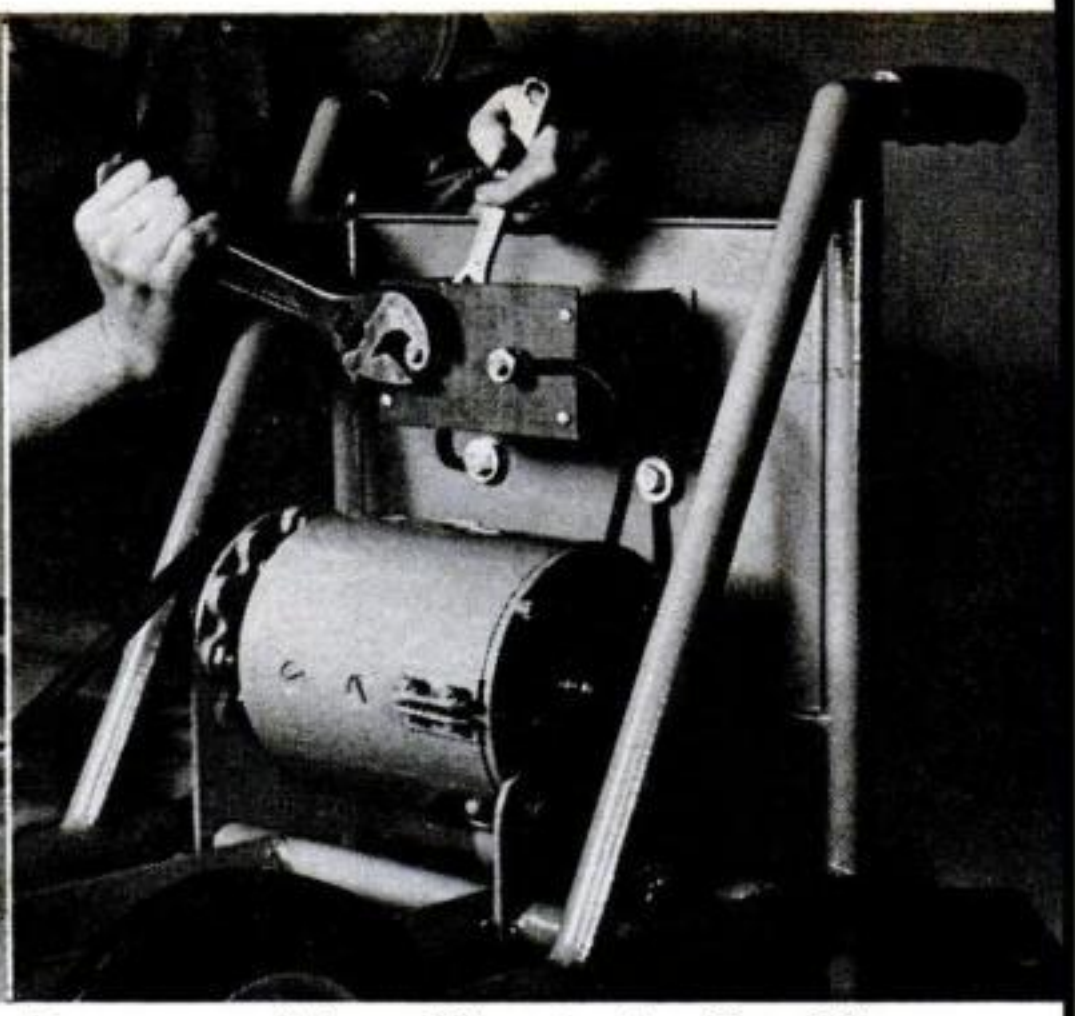


Cut mounting brackets for the generator from 3/16" steel plate, using cardboard templates to make sure you'll get a good fit. Notch the brackets and braze them to the pipe crosspieces. Elongated bolt holes drilled in the horizontal angle-iron supports for the engine will permit adjustment of the V-belt tension.



Reactance coil in welding circuit will stabilize the arc and minimize back-arcing at generator brushes. Mount coil above the generator on ¾" plywood. Use brass bolts for terminals. Wind the coil on a core of cold-rolled steel 5½" long and 1¾" in diameter. Center-drill and tap core for ¼" machine screws and mount it in a frame

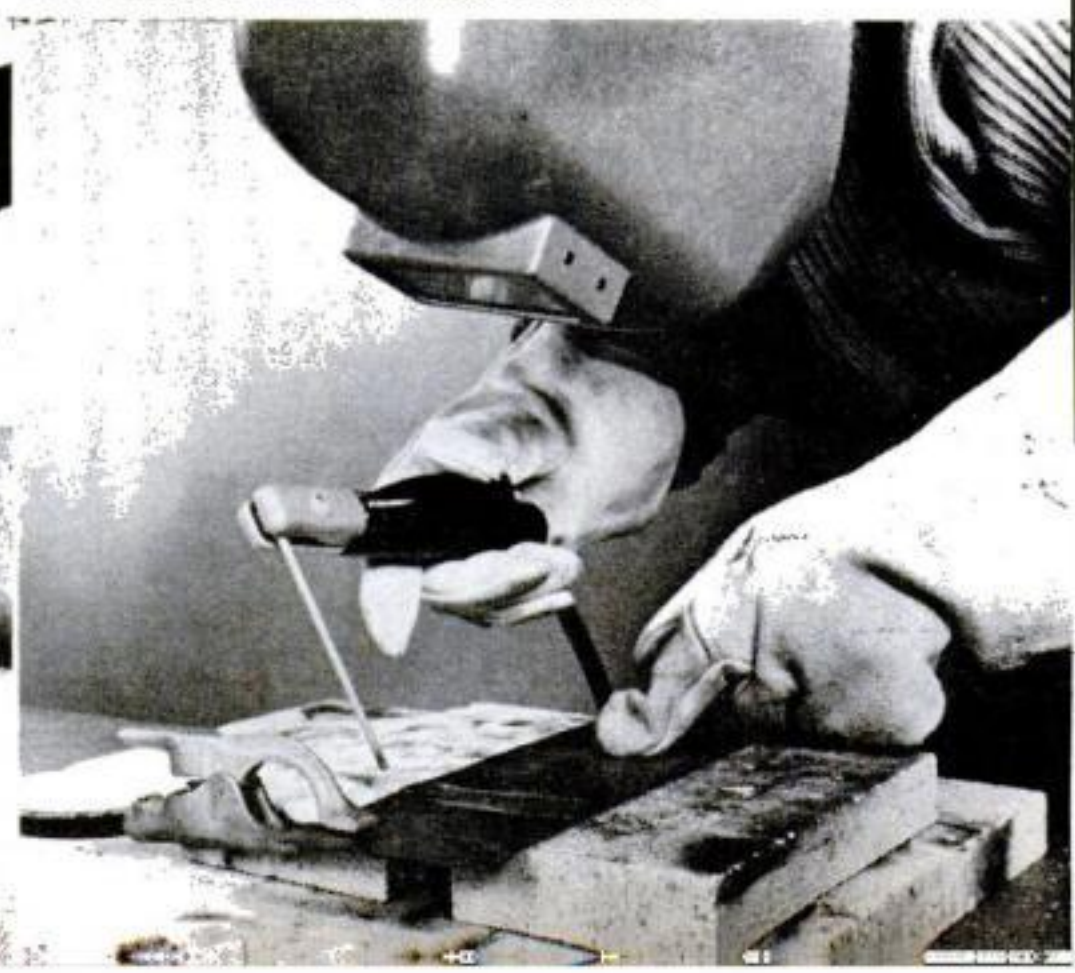
turn a 450-amp generator. It takes a 20-hp. engine to drive a 300-amp generator. With a 200-amp generator, you'd need a 12-hp. engine.

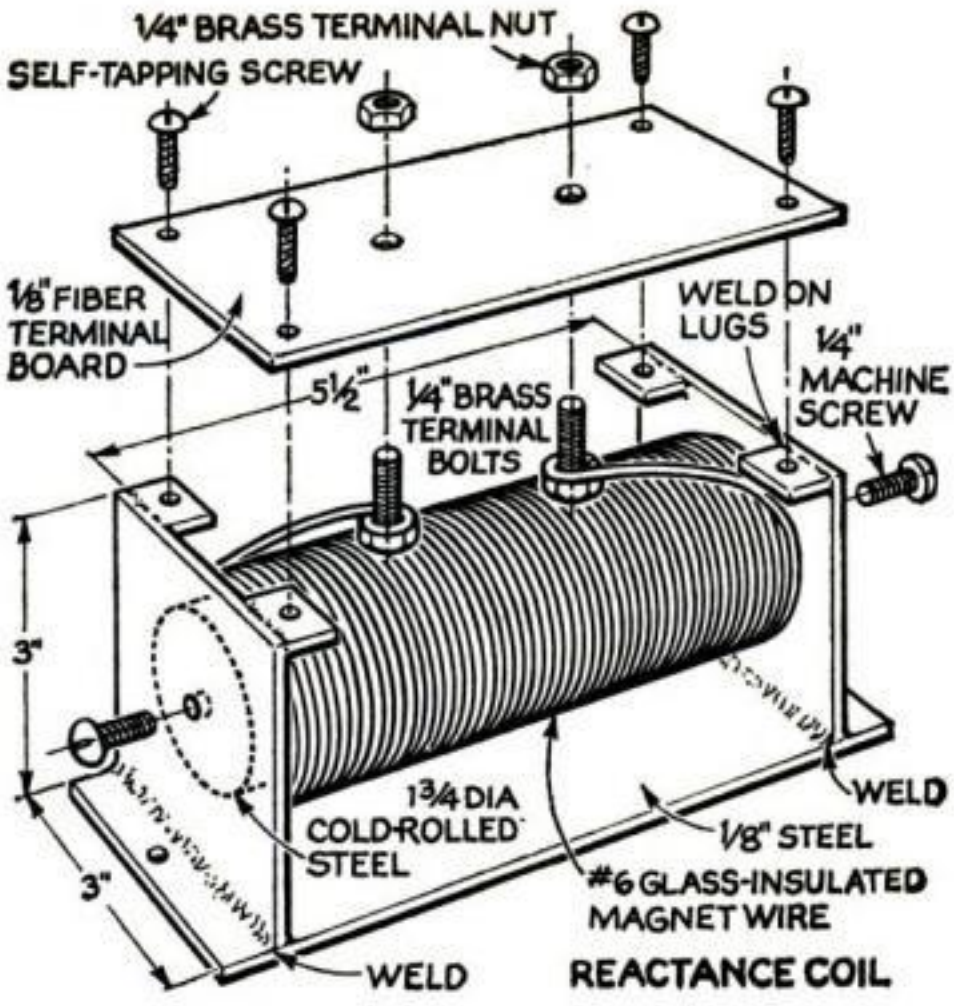
A welder that can deliver 150 amps—sufficient to burn ⅛" and 5/32" electrodes—is perhaps ideal for shop welding. With such a rig you can weld work of any thickness with repeated passes. Since a nine-hp. engine is needed to generate 150 amps, however, such a rig has size.

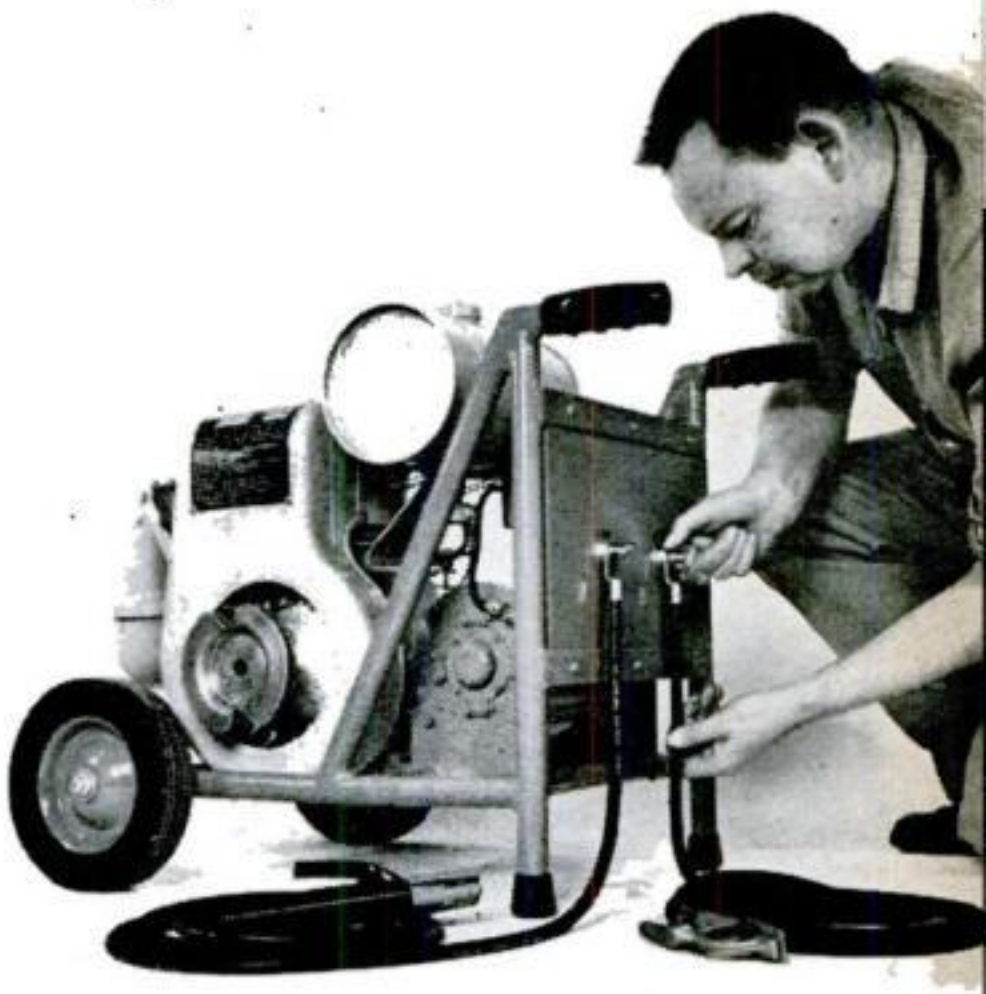
The combo. Coupling a generator with a six-hp. engine will deliver 75-100 amps, making a slick portable arc welder. Burning 1/16" and 3/32" electrodes, a unit with this capacity is adequate for most shop welding and is particularly useful for auto-body and sheet-metal welding.

Copper-clad carbon electrode is used for carbon-arc welding, brazing, and cutting. A carbon of ¼" diameter requires a current of about 100 amps for welding or brazing, higher current for hole-burning or cutting. Grind the carbon to a point and mount it as shown in photo below.

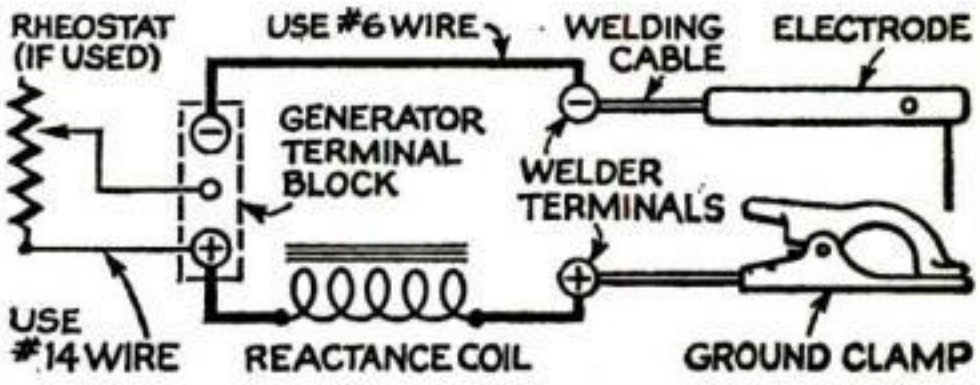
How much amperage? You can learn to judge this for ordinary welding through trial and error. Practice with 1/16" or 3/32" contact-type mild-steel electrodes on light scrap metal. Incline the electrode 15 degrees in the direction of travel and drag it slowly along the joint.







of ⅛" sheet metal, making sure the core ends and frame make good contact. Then wrap the core with glass cloth and wind on three layers of No. 6 glass-insulated magnet wire. Connect coil's leads to terminal screws on a terminal board made of ⅛" fiber board. Cover coil with taped-on armature paper. Ready-to-use coil is about $10.



Attach welding cable 10′ or 15′ long to the terminals with wingnuts. This cable has many fine strands for flexibility. Label the terminals positive and negative. For welder shown, No. 4 copper cables with light-duty (200-amp) electrode holder and ground clamp are okay.

If you own a garden tractor or snow blower with a six-hp. or larger engine, you can bracket-mount a generator on the chassis and improvise a V-belt drive. Remember when making supporting brackets that aircraft generators rotate counterclockwise (viewed from the flange-mount end).

The armature of the generator is hollow. A floating quill shaft—the splined shaft projecting from the flange-mount end—extends through it and drives the generator at the commutator end. This spring-tempered quill acts as a torsion bar to ease mechanical shock when amperage is drawn suddenly from the generator.

Belt-driving a generator. If the output is 200 amps or higher, the best way is to rig an auxiliary stub shaft between self-aligning ball-bearing pillow blocks. This stub shaft, which mounts the pulley, is aligned with the generator's axis and connected to the quill with a flexible coupling. Surplus houses sell the parts.

With a smaller generator, a simpler expedient is practical. You can remove the generator's quill—slipping off a retaining ring releases it—and at the unsupported end braze on a bushing that will fit the inside diameter of the generator's front bearing. This is an easy metal-lathe job. Bore the bushing, silver-braze it to the quill, and mount the quill in the lathe to turn the bushing's outside diameter for a press-fit into the bearing. Also turn or grind off the splines from the quill's larger end to simplify mounting a pulley.

If you use large-diameter pulleys to minimize slippage, a single B-width V belt is adequate for a six-hp. engine. Twin-groove pulleys with twin belts are needed for nine- and 12-hp. engines. When figuring the pulley-diameter ratio needed to turn your generator at operating speed, remember that the engine will slow somewhat under load.

Wiring the generator for welding is just a matter of connecting the field windings in parallel with two large main terminals. Increasing the r.p.m. of the generator will then increase both the voltage and the amperage delivered at the main terminals.

If you're using a 200- or 300-amp gen-

[*Continued on page 186*]

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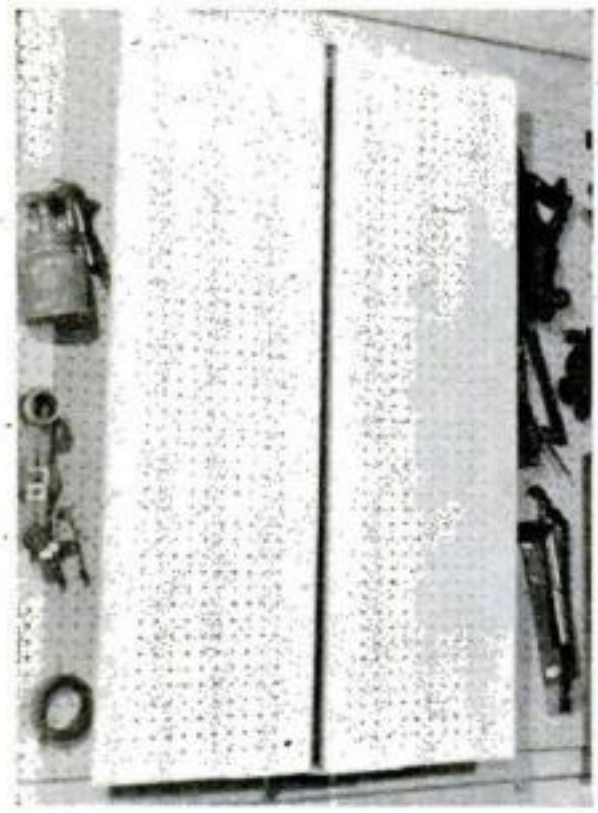
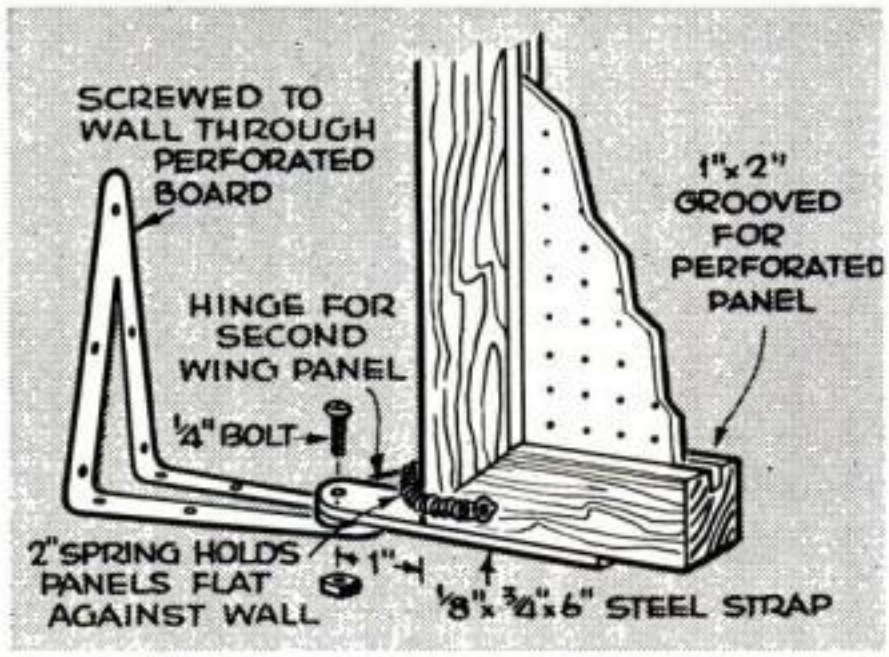
Short Cuts and Tips FROM PS READERS



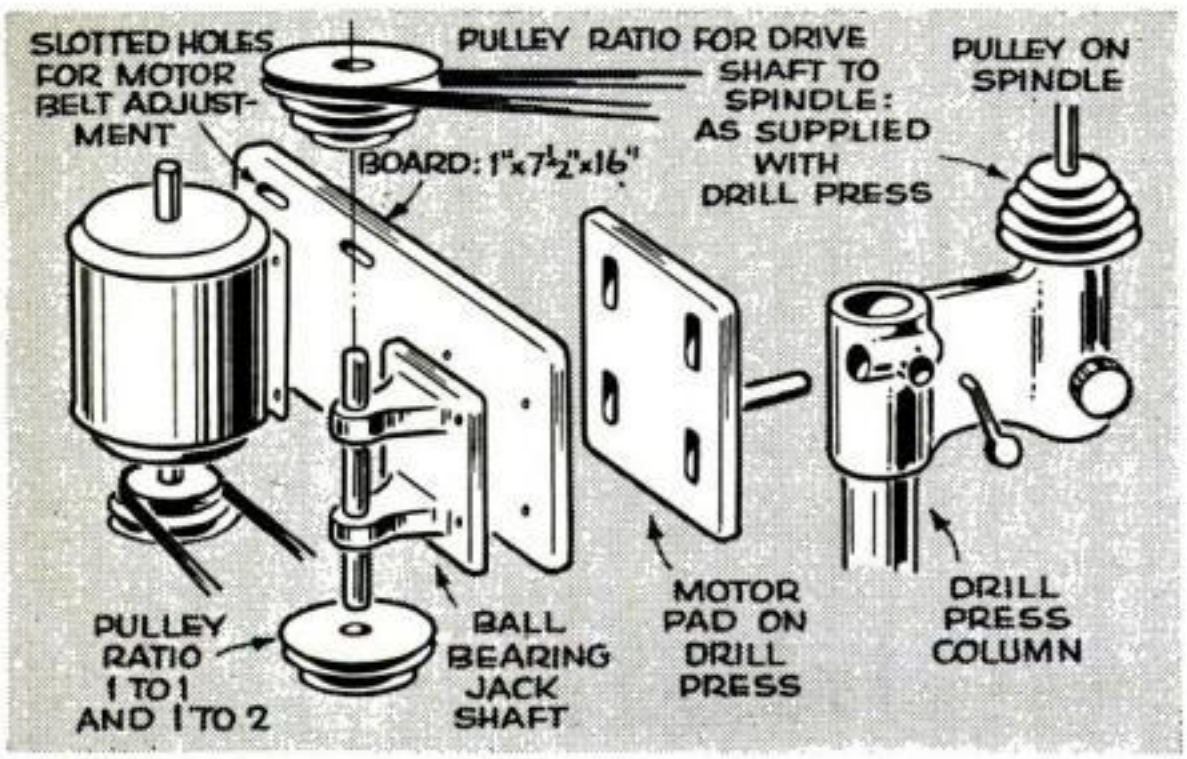
Wings increase tool-board space

Hinged wings made of framed perforated hardboard greatly increase the storage capacity of a tool board. Form hinges from ⅛″-by-¾″ steel strap 6″ long. Screw to the ends of the wings as shown and mount on shelf brackets attached to the original tool board. Use ¼″ bolts for hinge pins. Fasten a 2″ section of screen-door spring across the back of the wings near the lower hinge so the panels swing back against the wall after you have removed or replaced tools.—*W. G. Waggoner, Sacramento, Calif.*


SCREWED TO WALL THROUGH PERFORATED BOARD
HINGE FOR SECOND WING PANEL
¼" BOLT
1"x 2" GROOVED FOR PERFORATED PANEL
2" SPRING HOLDS PANELS FLAT AGAINST WALL
1"
⅛"x ¾"x 6" STEEL STRAP

▶▶▶Tying the foot portion of an old nylon stocking over the end of the water-drain hose of a portable clothes washer will trap the lint before it can plug up the drain or clog the drain screen of a sink or washtub. —*Mrs. J. H. Scharff, Verona, N.J.*

▶▶▶If plugged nailholes still look like plugged nailholes after painting, paint over the holes without filling, and then cover with bits of cellophane. Now, when carefully painted over, cellophane and hole will disappear.—*Ken Murray, Colon, Mich.*


SLOTTED HOLES FOR MOTOR BELT ADJUSTMENT
PULLEY RATIO FOR DRIVE SHAFT TO SPINDLE: AS SUPPLIED WITH DRILL PRESS
PULLEY ON SPINDLE
BOARD: 1"x7½"x16"
PULLEY RATIO 1 TO 1 AND 1 TO 2
BALL BEARING JACK SHAFT
MOTOR PAD ON DRILL PRESS
DRILL PRESS COLUMN

Drill-press drive gives wide speed selection

Give your drill press several slow speeds for heavy work by mounting a belt-driven ball-bearing jackshaft unit between the motor and spindle. The mounting board can be 1″ hardwood. The arrangement shown at left gives about 240, 400, 650, and 1,000 r.p.m. at the spindle. Speed is doubled by shifting the lower belt.—*L. W. Smith, Washington, D.C.*

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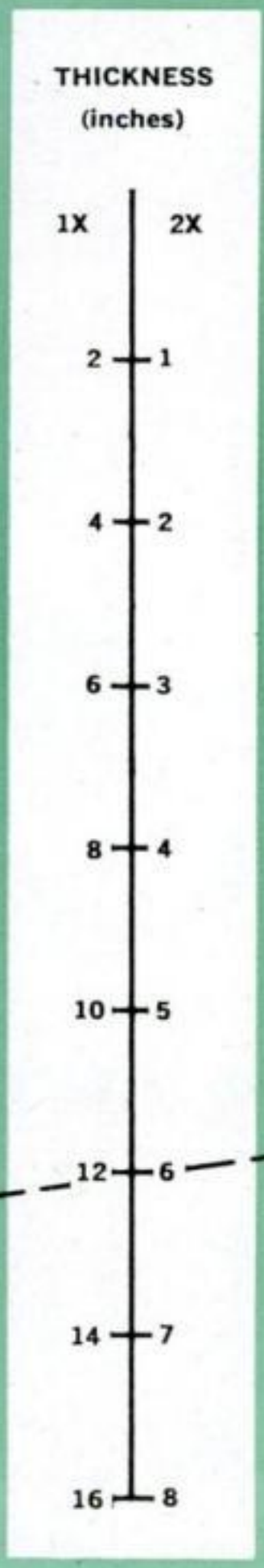
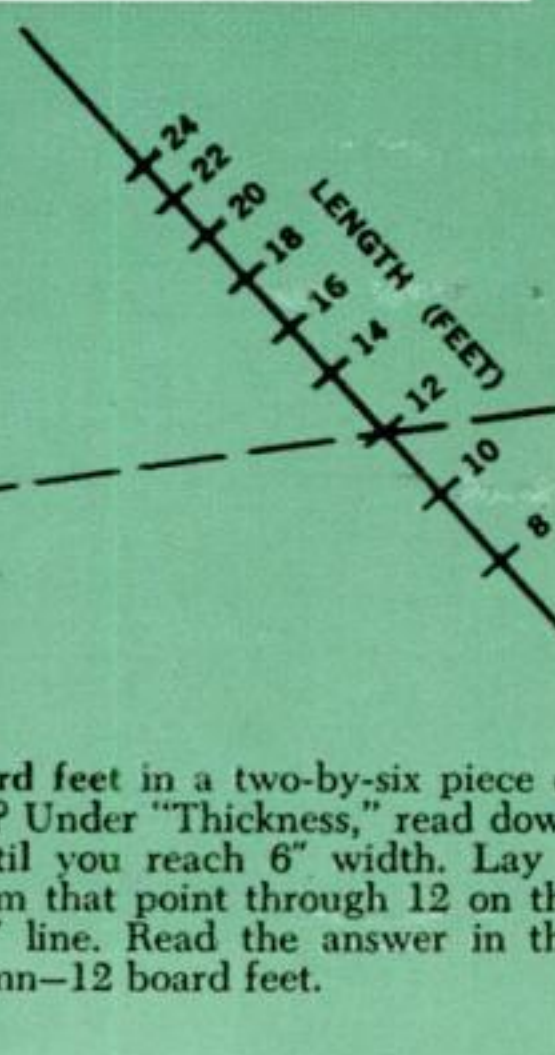
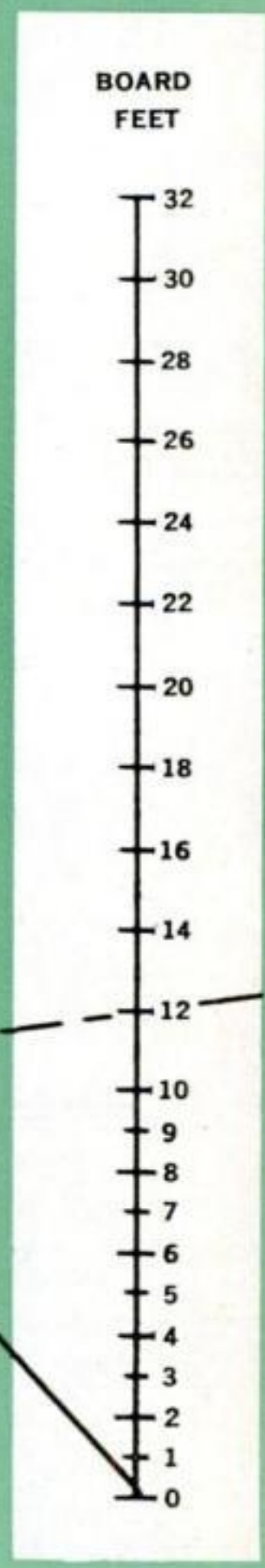
Popular Science

Handy Lumber Calculator



NOMINAL (inches)	ACTUAL (inches)
1 x 2	¾ x 1⅝
1 x 4	¾ x 3⅝
1 x 6	¾ x 5⅝
1 x 8	¾ x 7½
1 x 10	¾ x 9½
1 x 12	¾ x 11½
2 x 3	1⅝ x 2⅝
2 x 4	1⅝ x 3⅝
2 x 6	1⅝ x 5⅝
2 x 8	1⅝ x 7½
2 x 10	1⅝ x 9½
2 x 12	1⅝ x 11½





EXAMPLE

How many board feet in a two-by-six piece of lumber 12′ long? Under "Thickness," read down under "2X" until you reach 6″ width. Lay a straightedge from that point through 12 on the "Length (Feet)" line. Read the answer in the right-hand column—12 board feet.

IF YOU find it hard to figure the cost of lumber for a project when you are quoted the cost per board foot, use this calculator to get a quick answer. It gives you the number of board feet in one piece; multiply this by the number of pieces. A board foot is equal to one square foot of lumber 1″ thick. Lumber dimensions are nominal—the size of the lumber *before* it is dressed. The center chart shows the nominal lumber sizes with their actual dimensions.

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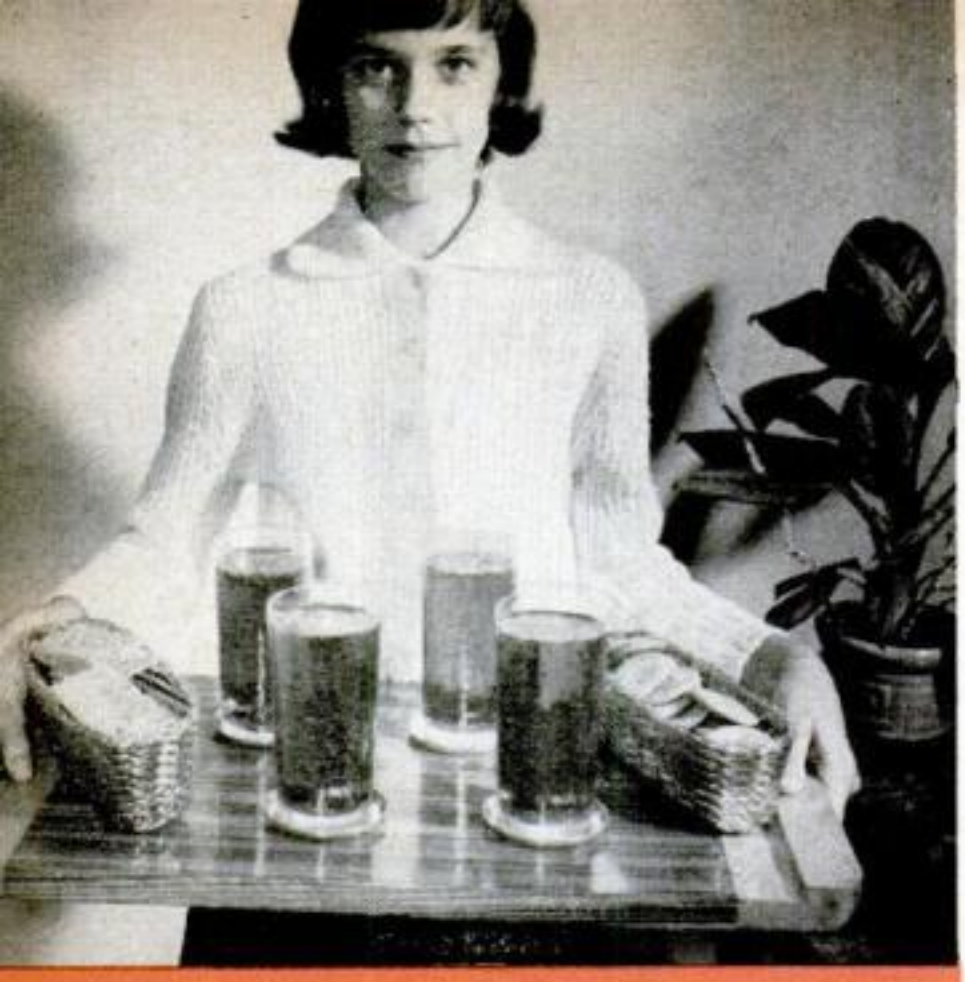
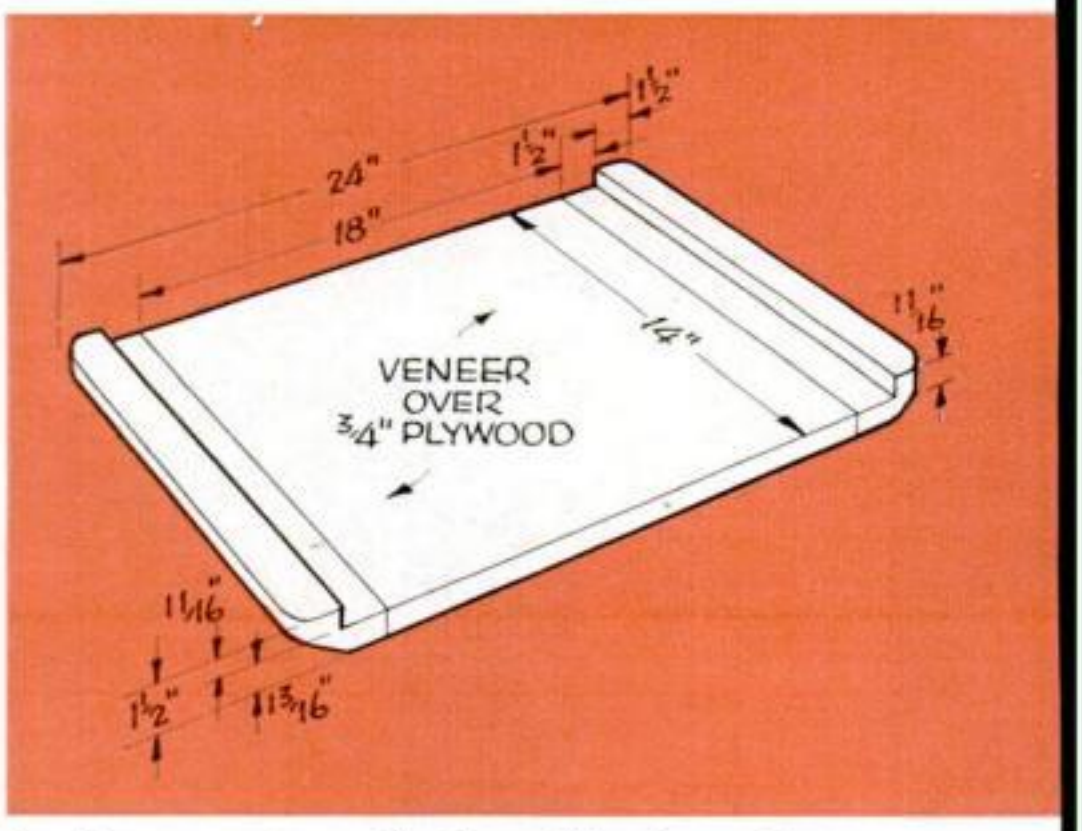


PS PROJECTS

Three Trays You Can Make

You Cover One



Serving tray is made from ¾" plywood, two strips of maple, and zebra-wood veneer.

By Richard Day

SERVE TV snacks on this unique tray made of zebra-wood veneer imported from West Africa. If the task of veneering scares you, it shouldn't. The fancy equipment and know-how that used to be necessary for successful veneering are as outdated as a Colt .44. All you need today are contact cement, a brush, and a veneer knife.

Zebra veneer, 1/28" thick, sells for 25

You Shape Two

By Walter E. Burton

YOU can put together either of these carrying trays in a couple of hours or less. Make them from any easily worked sheet metal such as aluminum, copper, brass, or monel. Or do as I did. Make them from a new material called Dynasyl. It's a sheet of aluminum with a polyester film laminated to one surface for decoration and long wear. It comes in various colors (the color is in the film), and can be bent, punched, drilled, and cut without the film coming loose. You can order it from the W. J. Ruscoe Co., 483 Kenmore Blvd., Akron, Ohio.

I made two trays. One is entirely of the new material, and one has wood strips for endpieces. The handles are heavy aluminum wire about .150" in diameter. Heavy cop-

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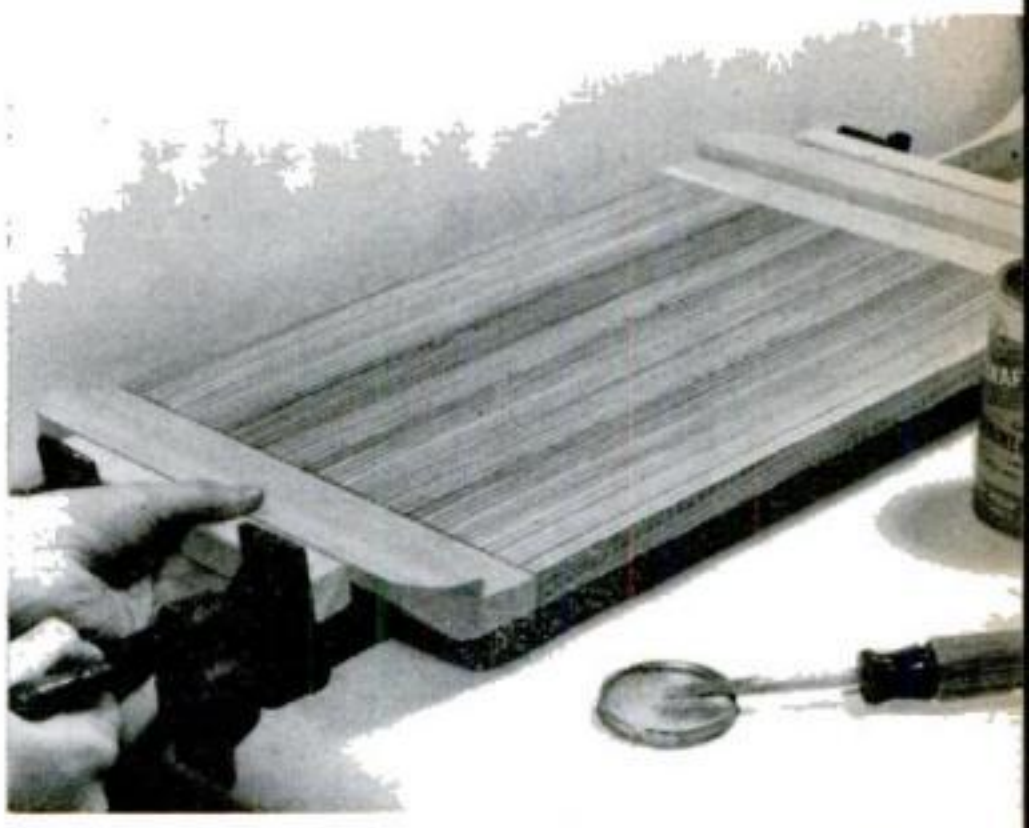
with Zebra-Wood Veneer

Apply veneer to the base with contact cement. Let veneer hang over edges, then trim flush.



Glue handles to each end of the veneer-covered plywood base. Use bar clamps to apply pressure.

cents a square foot. You need no more than three square feet to make the tray shown. The veneer knife can be ordered with the veneer. One place to get both, without going to Africa, is the Craftsman Wood Service Co., 2727 S. Mary St., Chicago.

Brush contact cement on the ¾" plywood base and on the back of the veneer strips. Give each at least three coats and let the last coat dry until it is no longer tacky. Then lay down the veneer, letting some hang over all four edges. Use a hammer and wood block to tap the veneer firmly in place. Trim the veneer flush with the plywood edges. Then veneer the two exposed sides. Fill any mismatched joints with plastic wood, and fill the pores with wood filler. Sand with 4/0 paper. Make the handles of a contrasting solid wood such as maple. Glue the handles to the ends of the base. Finish with clear polyurethane, and cement felt to the bottom.

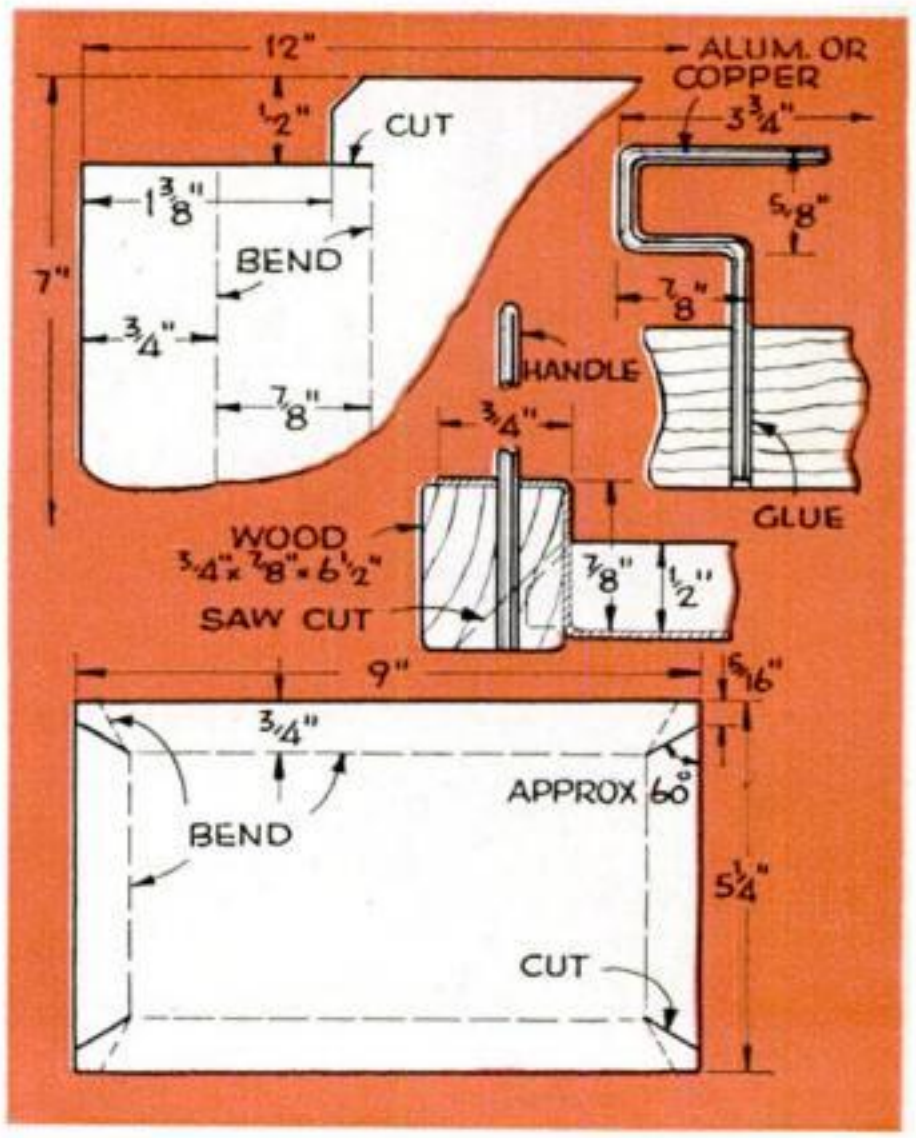
from Aluminum

per wire or brass rod could be used instead.

The all-metal tray is formed from a 6"-by-7" sheet with an embossed design and a gold coating. It is cut at the corners as in the diagram at right. The sides are bent to form inside angles of roughly 140 degrees. Glue the corners with epoxy (or put a rivet or two in each corner), and trim off any excess metal at the overlaps. The wire handles are flattened at the ends and drilled for small rivets. I flattened the handle ends by squeezing them in a vise. A flat file between the handle and one jaw gave a textured finish to the metal. The textured side is mounted out. Use aluminum nails or escutcheon pins as rivets. Cut to length, insert in holes, and peen the cut end.

The tray with wooden ends is made from a 7"-by-12" sheet of smooth aluminum with a deep-red coating, two strips of maple, and

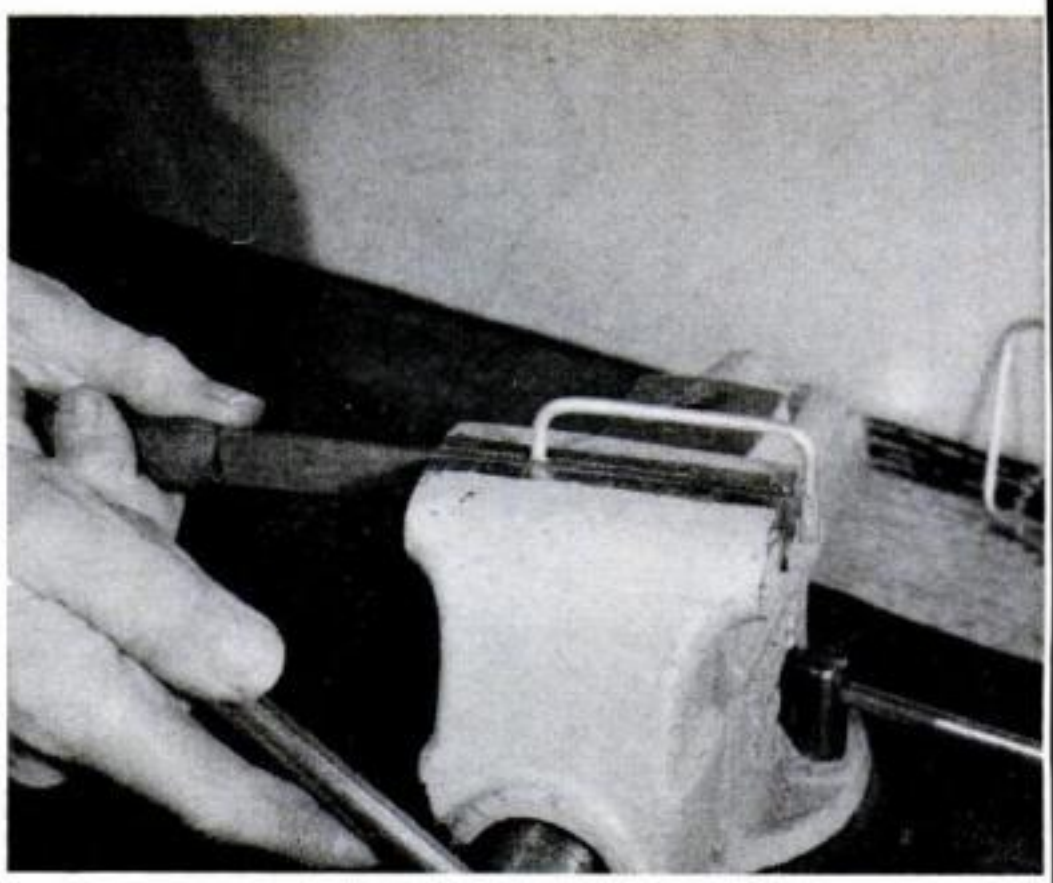
CONTINUED



Urheberrechtlich geschütztes Material

two pieces of heavy aluminum wire. The ends of the aluminum sheet were bent around two sides of the endpieces. The tray projects about ¼" beyond the aluminum at each end, to fit into slots in the wood endpieces. Use epoxy cement to secure the projections in the slots and to attach the wood endpieces to the metal. Bend handles from heavy wire or rod. Clamp the wood endpieces and drill holes for the handles through the metal and into the wood. Size holes to give a fairly tight fit, and then glue the handles in with epoxy.

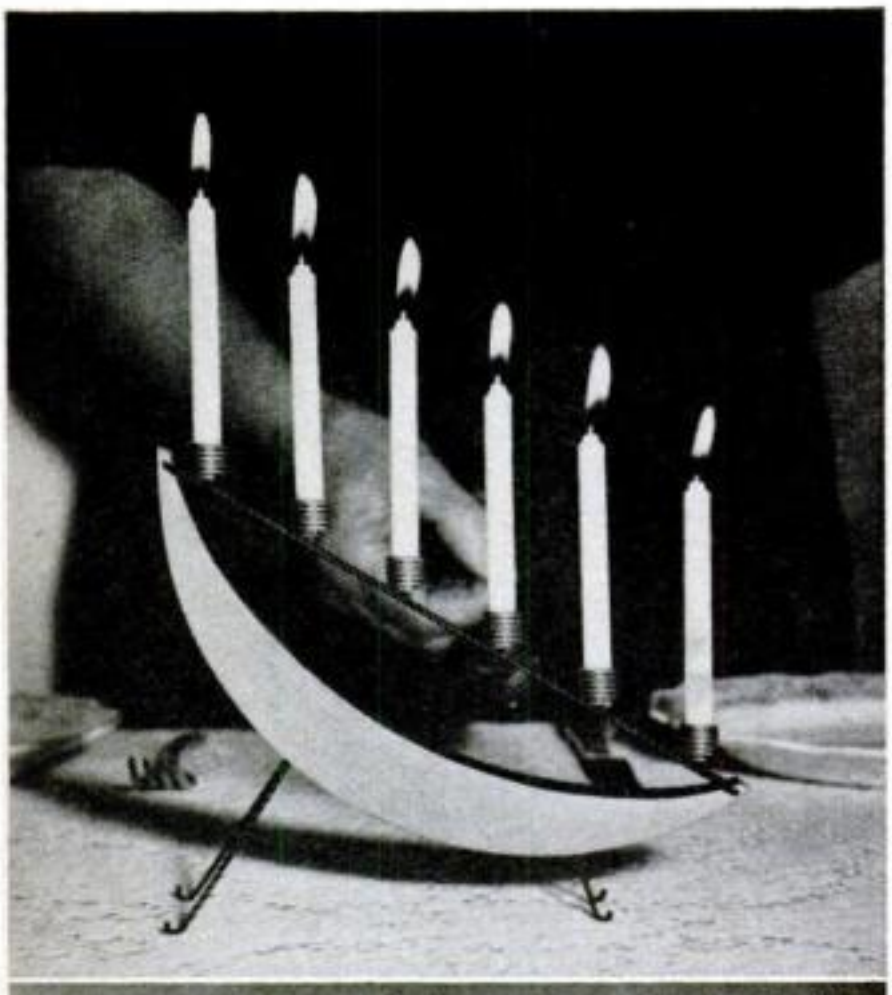
As a finishing touch, glue felt or flannel disks on the bottom of the tray near each corner to prevent marring polished finishes, and coat the wood with clear varnish.



Flatten tray-handle ends in a vise, using a flat file on one side to emboss texture on them.

Two Candle Holders

One Takes Its Shape from the Moon



THIS holder is designed for use as a dinner-table centerpiece. The coiled copper-wire candle holders and the ¾" wood body are painted a golden yellow, the two slanted supports and legs a dull black.

Shape the body from the pattern below and drill holes for the wire supports and legs. Angle the legs about 20 degrees. Turn up the ends to protect table linen.

Use 12-gauge copper wire for the coiled holders, slanted supports, and legs. Wrap five or six turns on a dowel of suitable size for the candles. (The candles shown are about 4" long and ⅜" in diameter.)

Solder a 1" piece of wire across the center of each coil. Solder this straight wire to the slanted supports after the latter are in place. A spring clothespin (lower photo) will hold one end of each 1" wire while you solder the other.—*Clifton Morris, Lubbock, Tex.*

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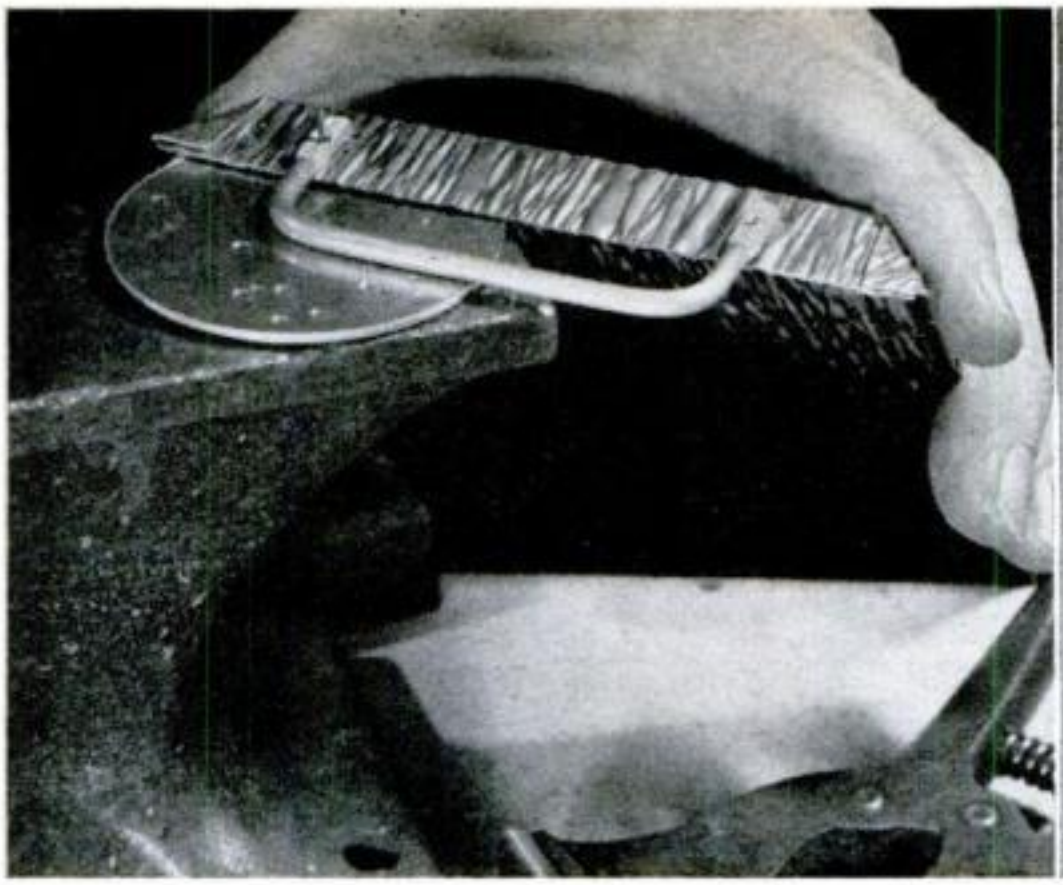
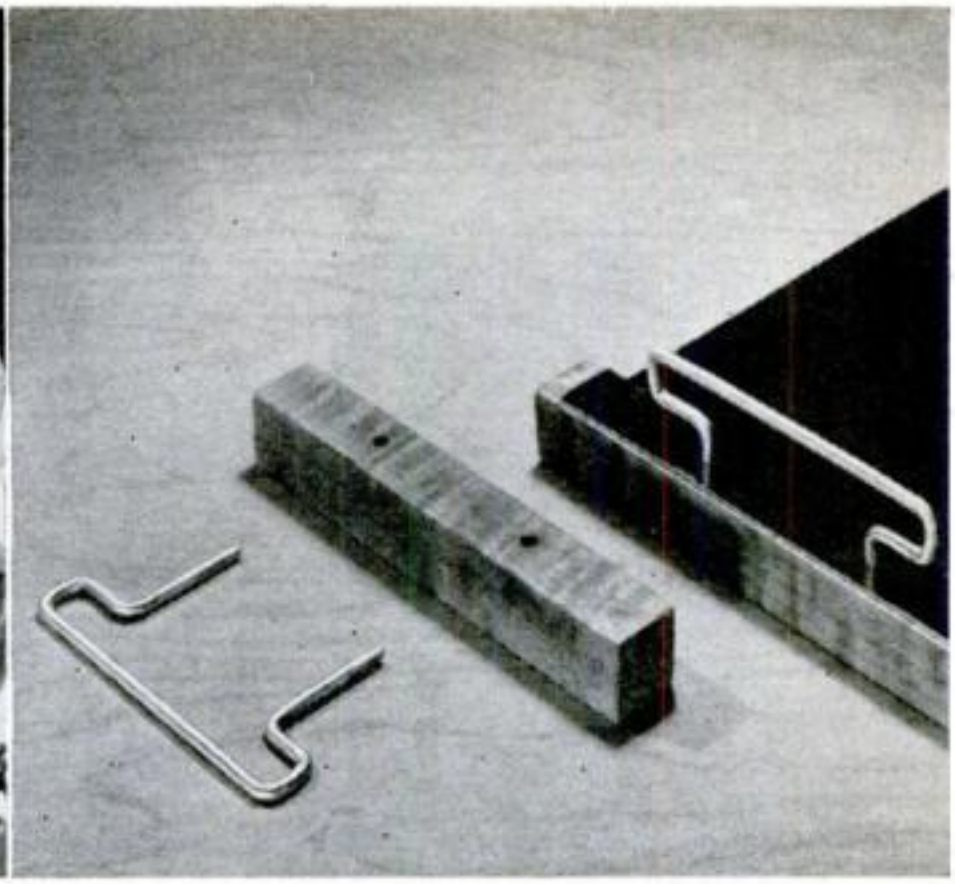


Rivet wire handle to tray with escutcheon pins, cut to length after they have been inserted.



Wood endpieces are fastened to aluminum with epoxy. Handles are glued into tight-fitting holes.

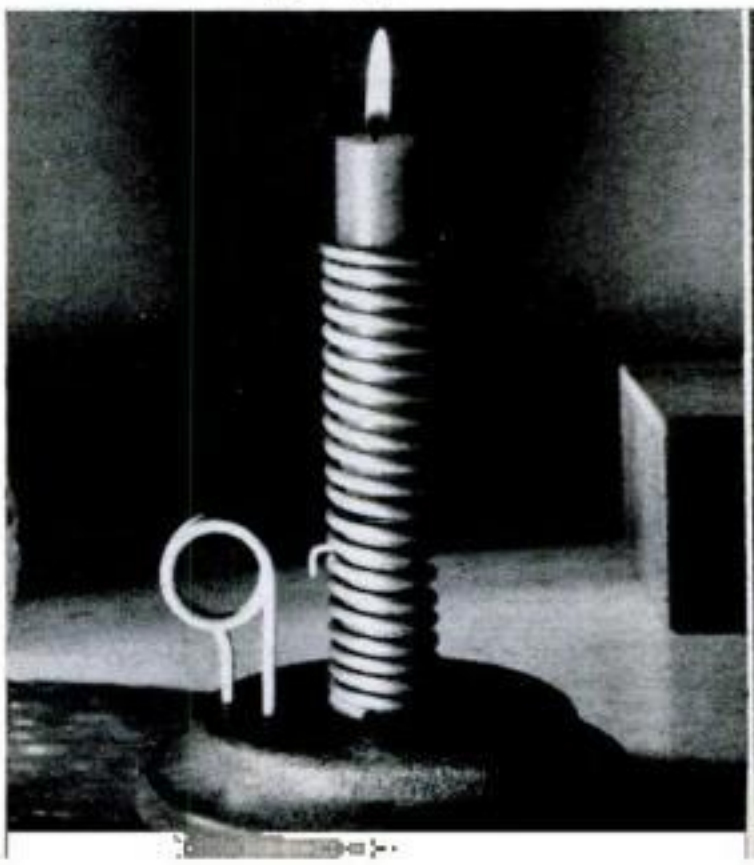
# of Unique Design

One Elevates the Candle as It Burns

AT HOME among modern as well as antique decorations, this candle holder has an adjustable plug that can be "unscrewed" to raise the candle as it burns shorter. Turn the base from a disk of cabinet wood. For a helix (coil spring), use a spring from your junk box. If you can't find a spring that will fit the candles you want to use, wind one from aluminum clothesline wire (as in the model shown), brass rod, or steel or copper wire. A metal rod or pipe makes a suitable winding mandrel.

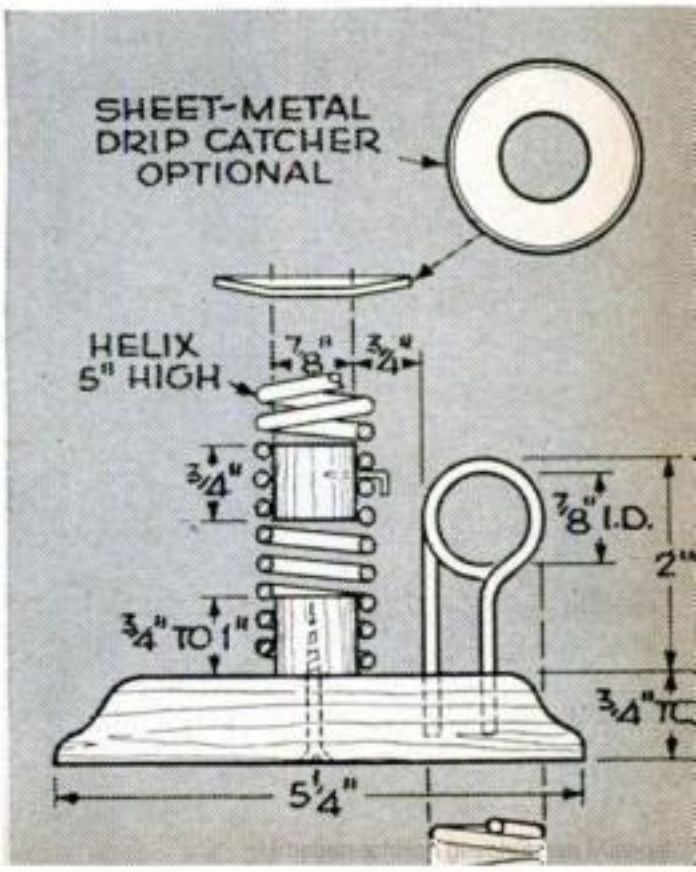
Make a wooden plug about ¾" long to fit tightly inside the helix. Screw the plug to the center of the base. Make a similar plug that slides easily inside the coil. Stain both plugs to match the base. In the sliding plug, install a nail, bent to an L shape as shown, to serve as a guide pin. Make the handle from the same material as the helix, and glue it into tight-fitting holes in the base. Glue felt or flannel to the base to prevent marring of polished surfaces. To catch wax from candles that are drippy, add a drip catcher as shown in the drawing.—*W. E. Burton, Akron, Ohio.*

Bent nail, inserted in movable plug, projects through spring coils. Plug supports candle.



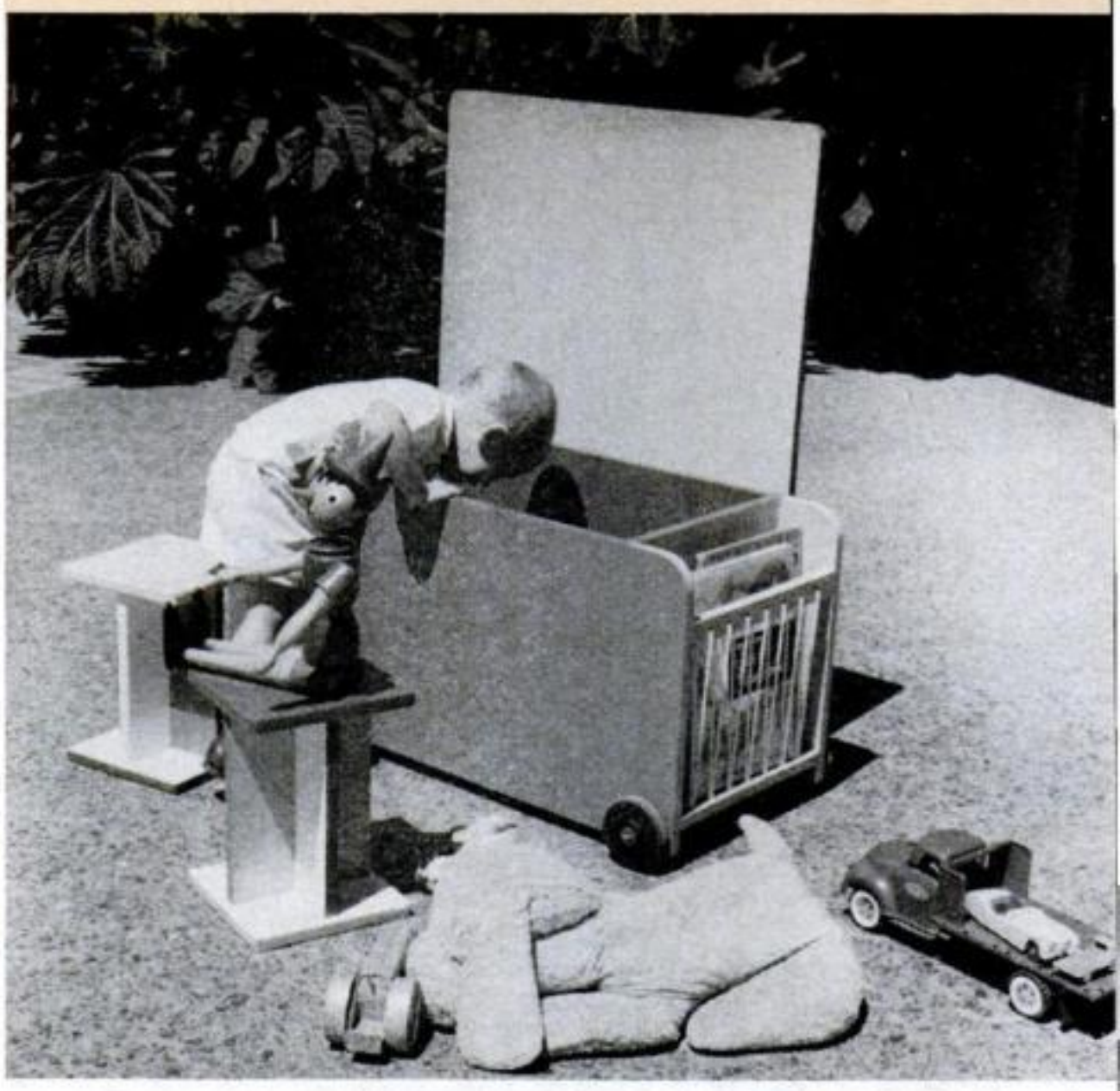
To raise candle as it burns down, turn the guide pin (nail) so it moves up the spiral.

Candle holder is made from a turned wood base, two wood plugs, and aluminum wire.



PS PROJECTS

A Chest for Toys



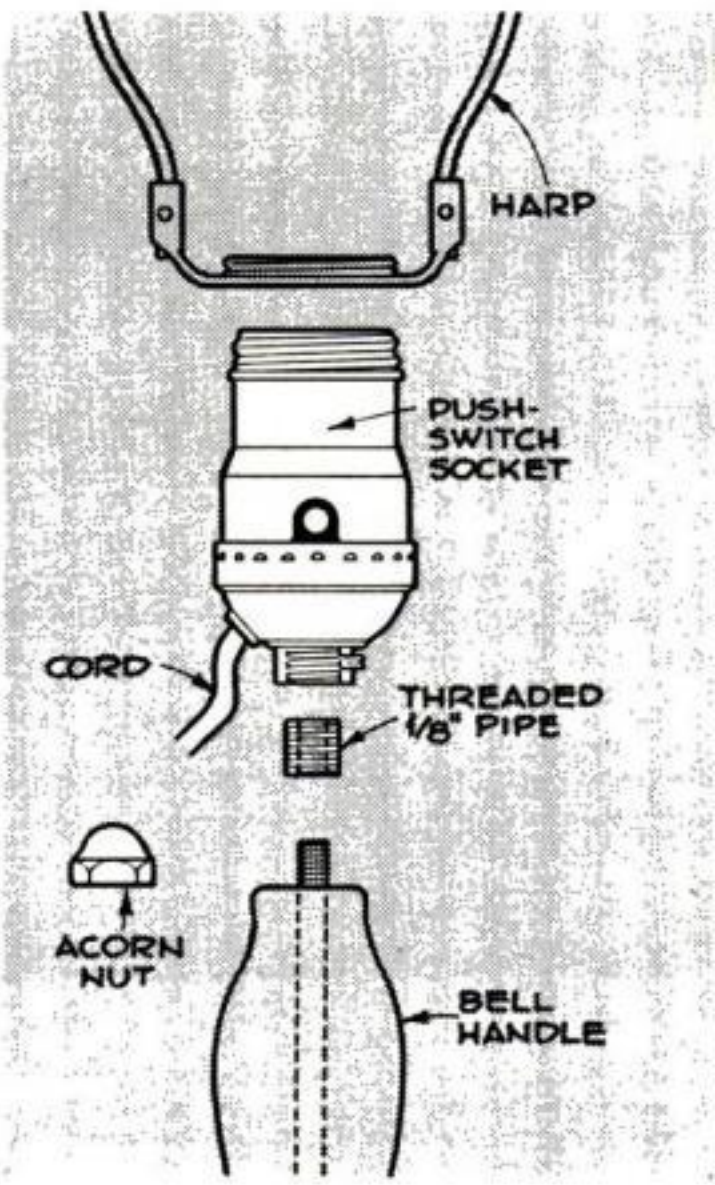
THIS chest is more than just a place to stow toys. The kids can pull out the stools and sit at the table-top lid for a session with coloring books stored in the end racks. It's simple to build. Except for two small pieces, it's made entirely of ¾" interior plywood. These two are the 1"-by-2" pine stretchers for the plastic-clothesline grille on the book rack. I put the chest on wheels because I had some handy, but casters would steer easier.

I cut the side panels first and dadoed them ¼" deep to fit the bottom and side

A Bell Lamp

Take a polished brass bell, mount a brass lamp socket on its handle, and top it off with a gold-foil shade to get a rich-looking lamp at modest cost. At dinner time, pick up the lamp and ring your guests to the table.

You can get hand bells from stationery stores or order them from Beckley-Cardy Co. (1900 N. Narragansett Ave., Chicago) or Bevin Bros. (E. Hampton, Conn.). For an adapter, use a short length of brass rod. Thread it on the outside to fit the lamp socket, inside to fit the handle stud.—*Art Trauffer, Council Bluffs, Iowa.*



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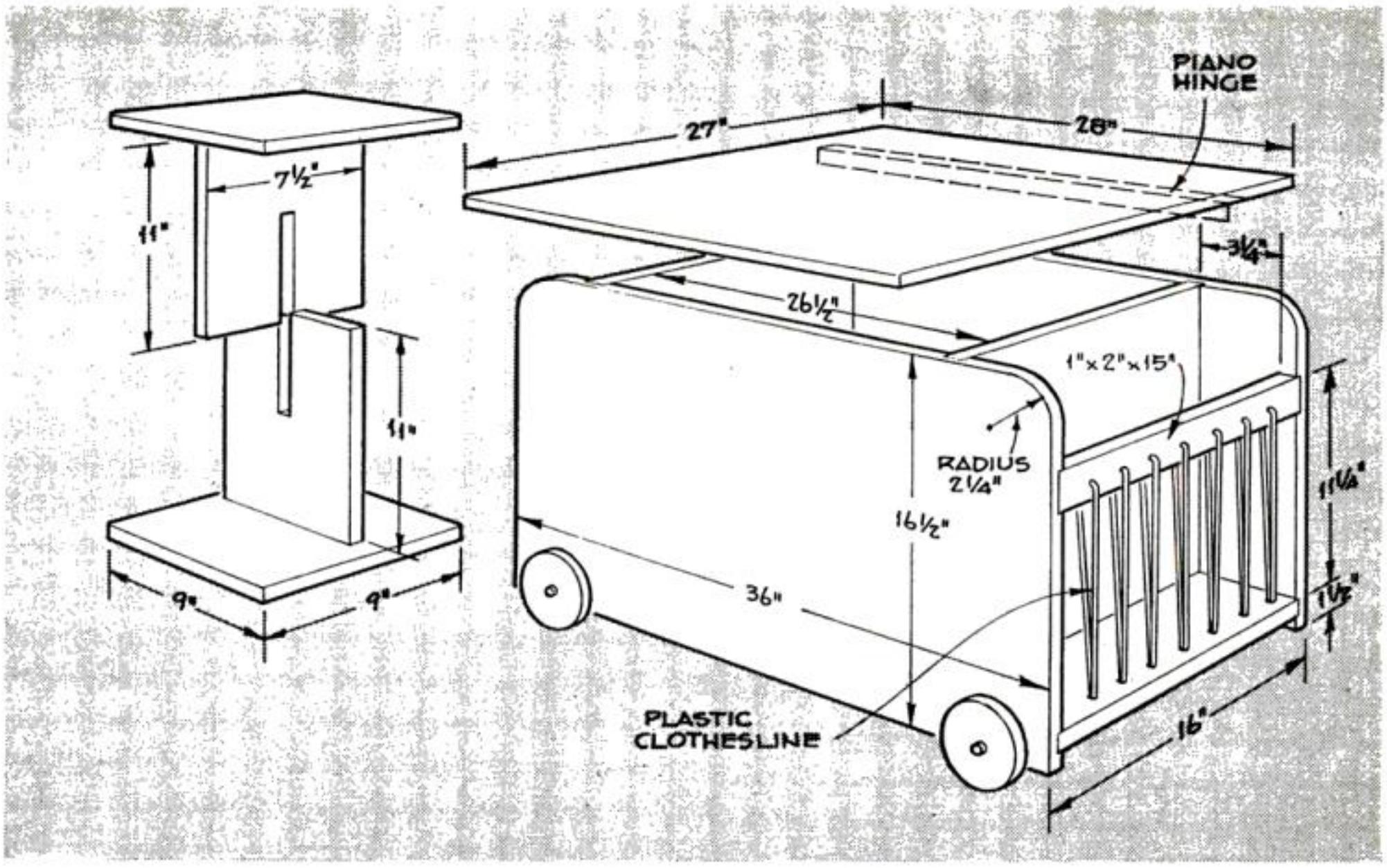
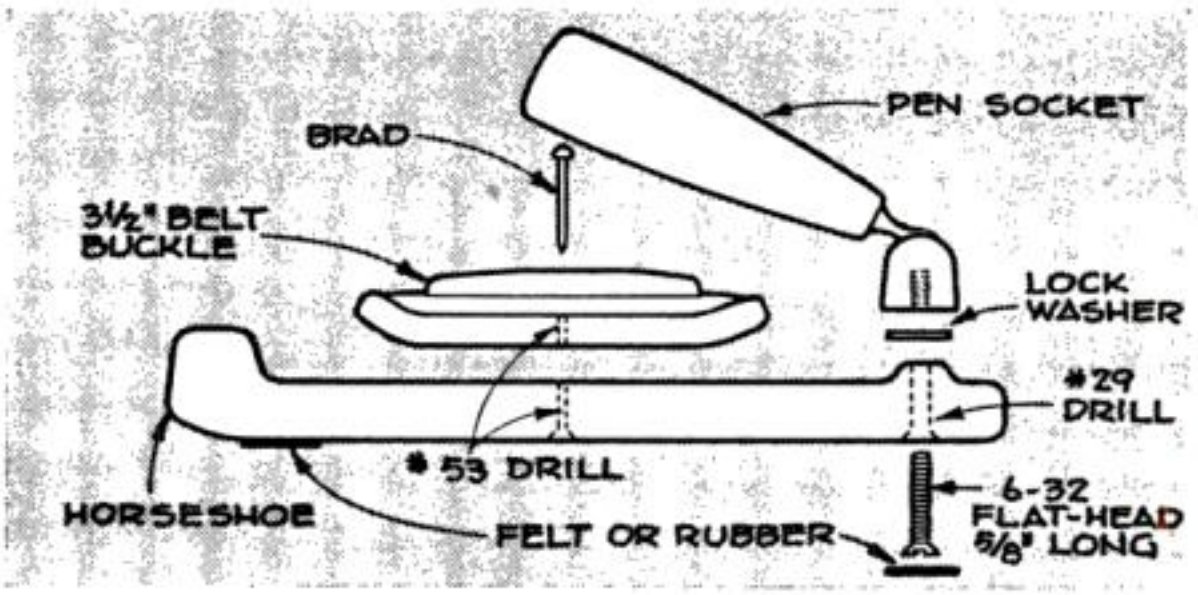


panels. The mortises for the stretcher pieces were chiseled out. The chest was put together with glue and six-penny nails. The table top is hinged with a piano hinge, but three 2″ butt hinges would do as well. The holes in the stretcher pieces are ¼″. But the corresponding holes in the chest bottom should be ⅜″ since here the plastic clothesline must pass through in double strands. *—Robert Gilmore, Sonoma, Calif.*



A Western Pen Holder

Add some atmosphere to your den or help corral the little cowpoke around the house while he does his homework with this Western-style pen holder you can make in an hour for $3 or less. It's made from a horseshoe that costs less than 50 cents at a livestock-supply store, a Western belt buckle you can get for about $1.50, and a pen swivel-socket from a craft-supply shop, stationery store, or secondhand shop.

Drill two small holes through the buckle and shoe and rivet the buckle in place with round-head brass nails. Mount the swivel socket on a screw. Use a flat-head screw and countersink the head. Glue felt to the bottom of the shoe to protect the desk top. *—Art Trauffer, Council Bluffs, Iowa.*

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PS PROJECTS

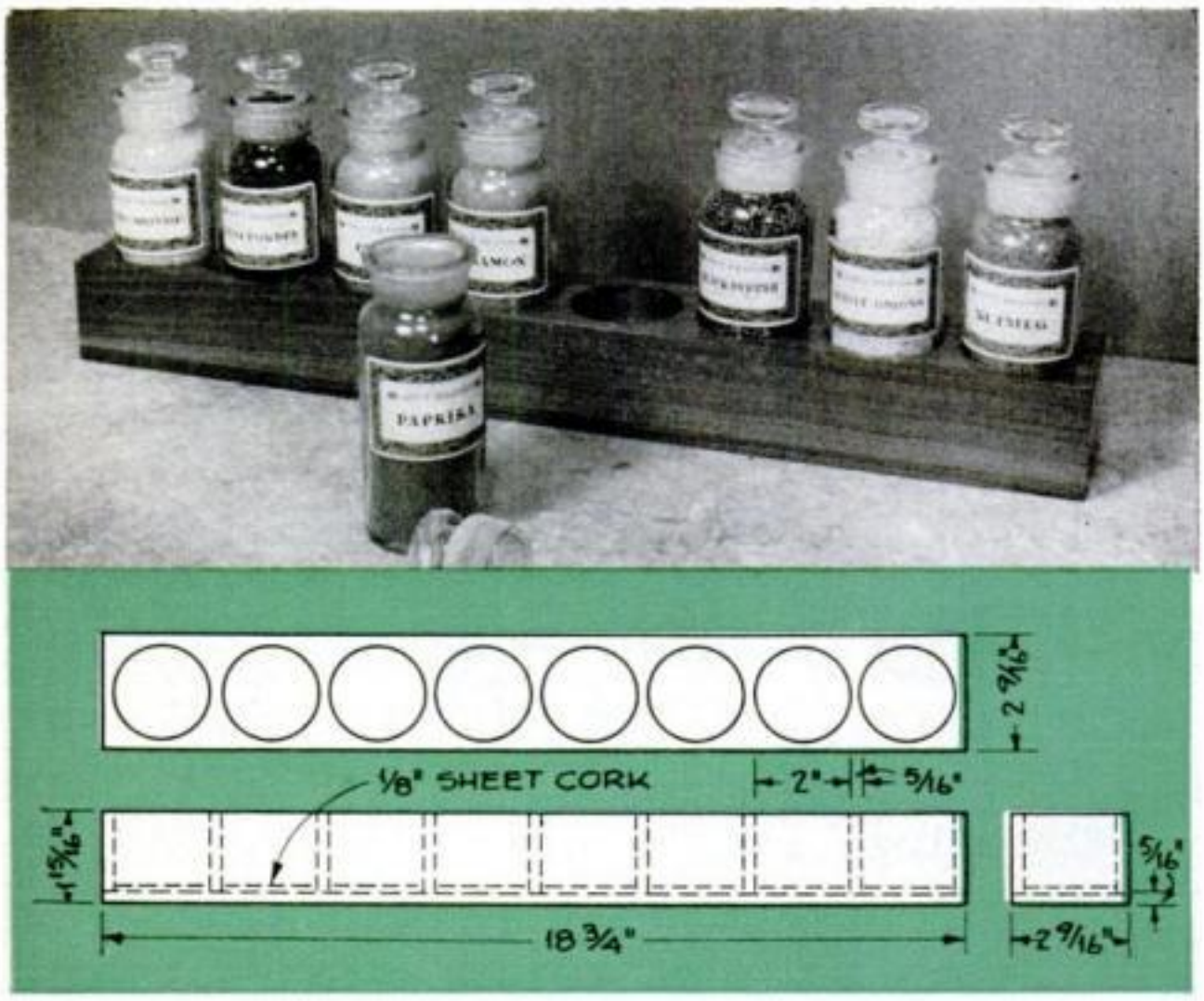
A Pine Fireside Stool

Simple construction of this pine bench makes it easy to put together in a single evening.

HERE is a Colonial-style pine bench that can be used as a fireside stool, lamp table, or coffee table. It also has a handy storage drawer. Except for the ¼"-plywood drawer bottom, all pieces are pine. For the top, you might use a 12"-wide pine board with a few attractive, but solid, knots.

Lay out the two apron pieces (cutting pattern above right). Jigsaw aprons and cutouts in legs. Notch legs ½" deep to take the aprons, with the aprons extending ¼" beyond the edge of the legs. Make the

Two Easy-to-Make



A FEW small pieces of walnut are all you need to make these handsome racks for apothecary-type spice jars. The rack at left can be made from one solid piece of wood. Just bore the holes so that they don't go all the way through the block, and glue cork pads in the bottom to cover up the lead-screw holes.

I made mine out of two pieces instead. I drilled the holes all the way through the block, sanded the inside of the holes with a drum sander, and glued a 5/16"-thick piece of the same stock on the bottom. I cut circles from

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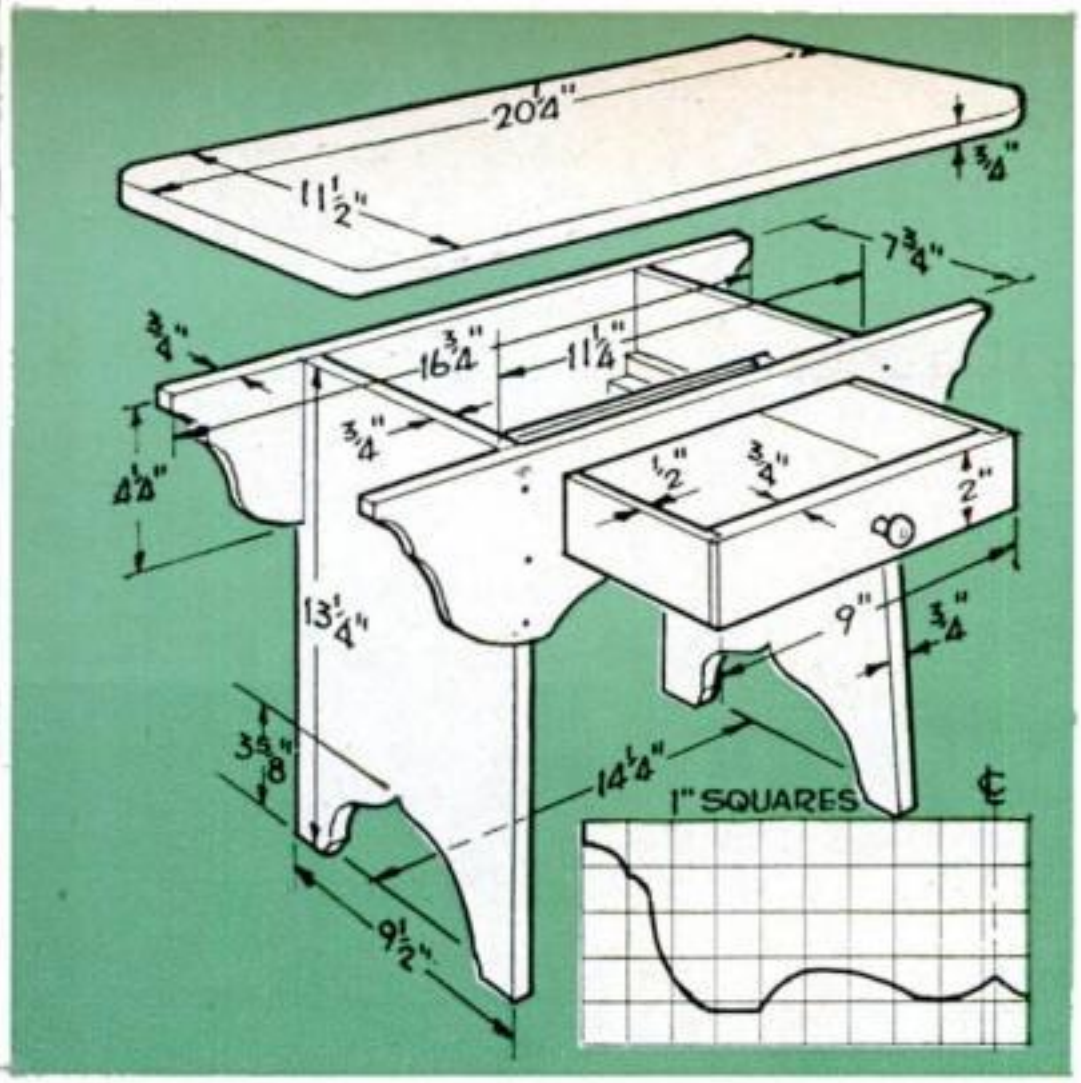
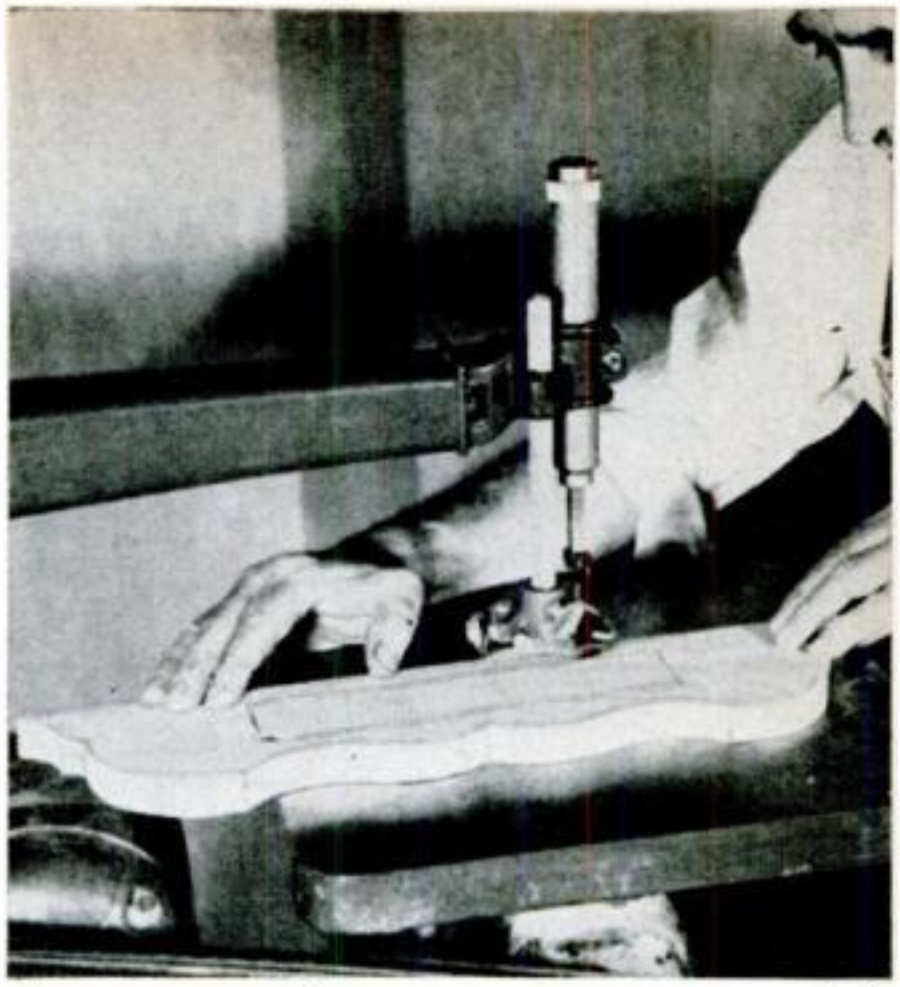




Jigsaw apron pieces to cutting pattern at left. Drill a hole to start cutout for the drawer.

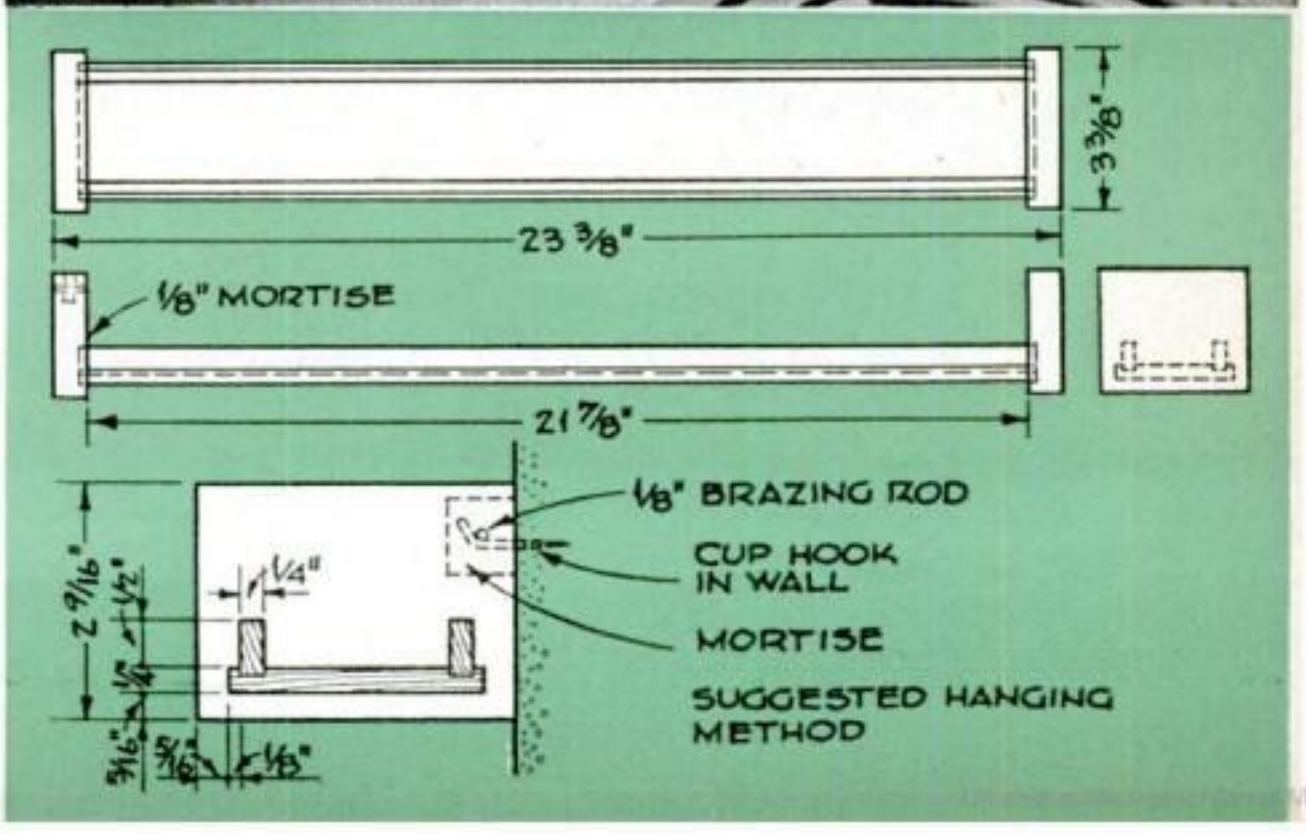
drawer runners from two strips ¾" by 1⅛" by 8½". Assemble with glue and finish nails. Set nails and fill the holes with putty. Sand the outside edges of the top, apron, and legs to a slight radius.

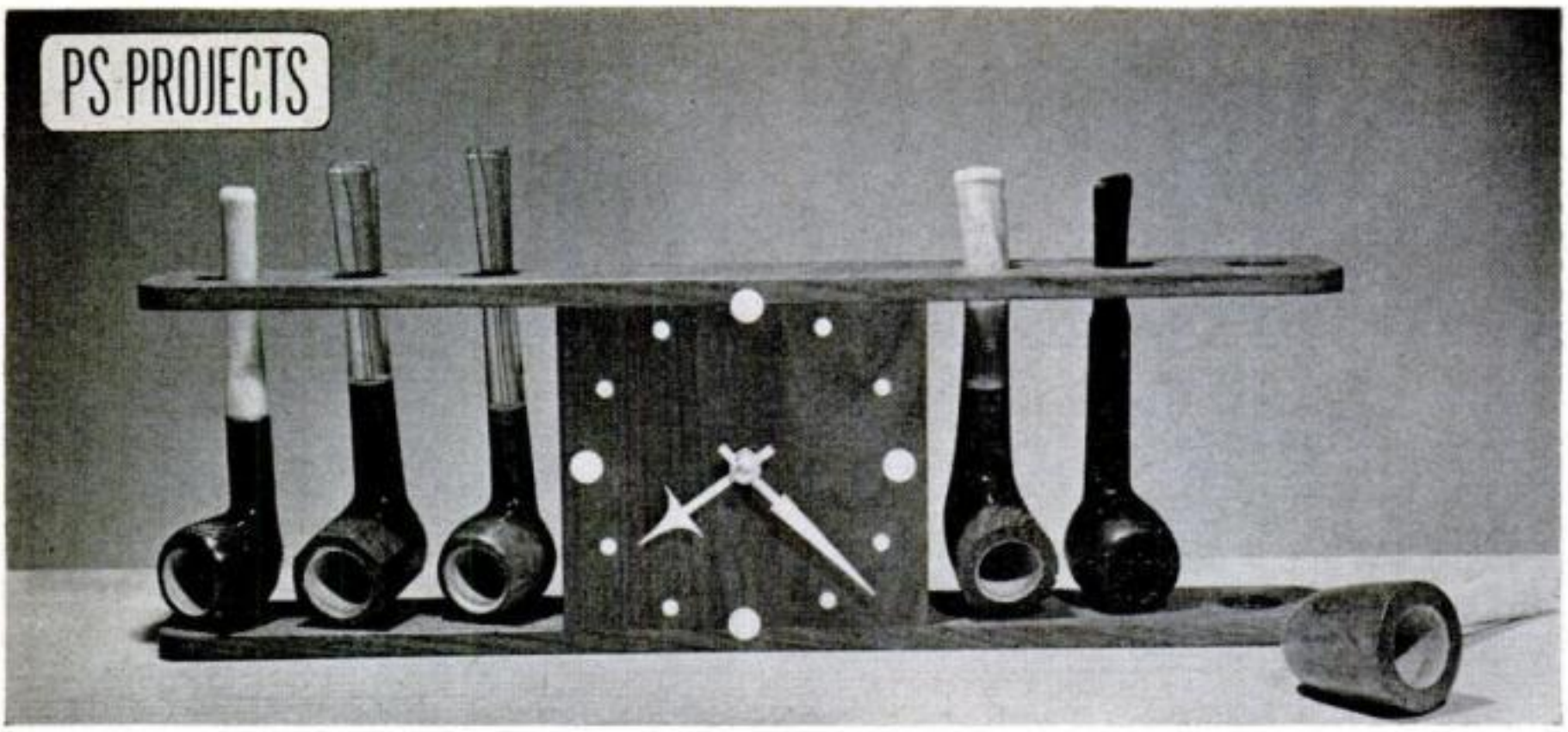
Finish-sand all surfaces. Finish the stool by first rubbing all surfaces with burnt umber to darken the wood and bring out the grain. Give it several coats of shellac, and rub down each coat with very fine sandpaper or steel wool. Wax and polish it.—*A. A. Altomare, NYC.*

Spice Racks

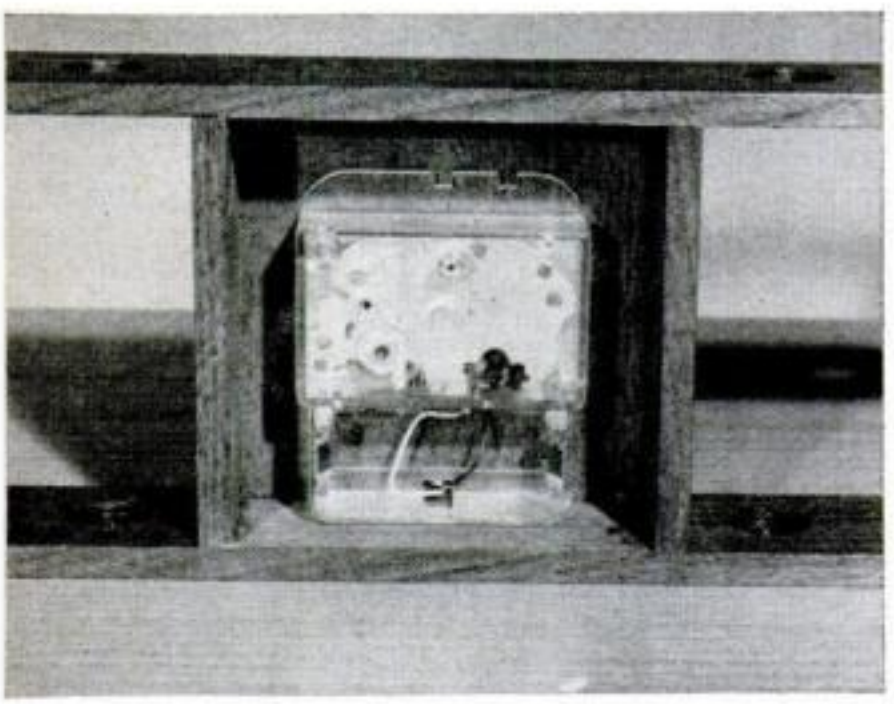
⅛" cork flooring for bottom pads, but gasket cork would do as well.

The rack shown at right has a bottom piece and two small railings resawn from a larger block. The bottom and railings were glued together, then squared up on the table saw after the glue had set. I held the bottom piece in position against the end block to lay out the mortise. The hidden hanger pins catch onto hooks screwed into the wall. The racks were sanded down and given a coat of clear penetrating sealer resin.—*Robert Gilmore, Sonoma, Calif.*

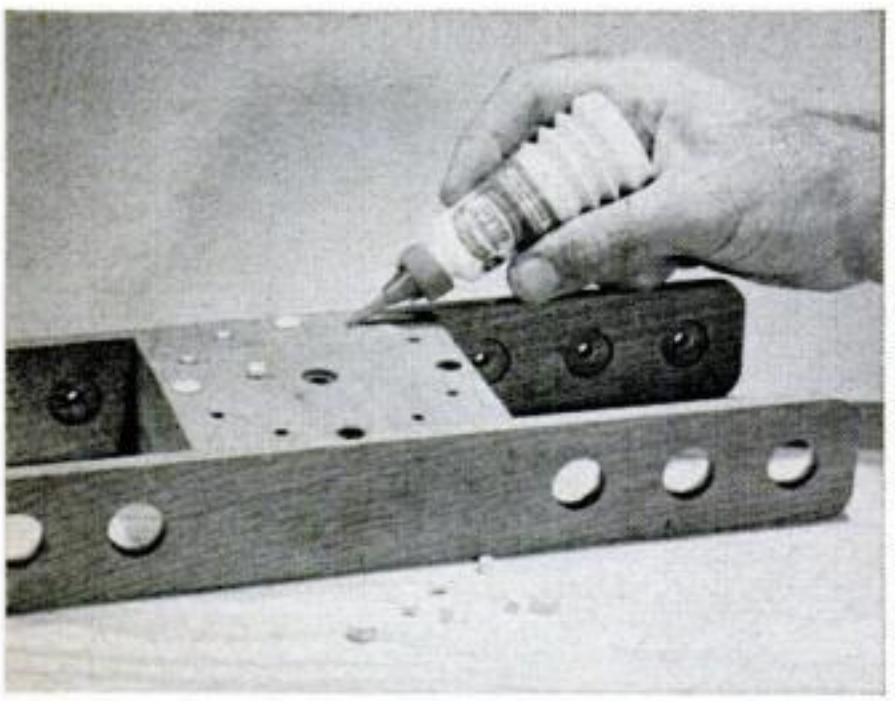




A Pipe-Rack Desk Clock



Rear view shows transistorized clock movement. C cell is snapped into place between the clips.

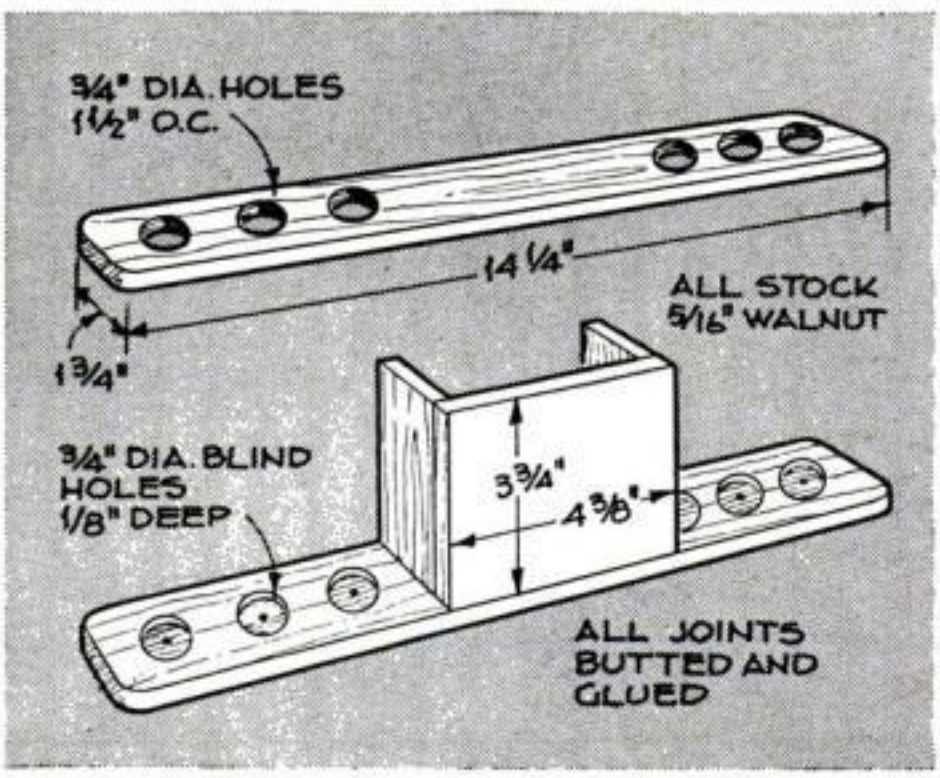


Numeral positions are marked with dowels of a contrasting wood sanded flush with face.

BESIDES holding six of your favorite pipes, this rack is also an attractive timepiece. No messy wires, and no winding either. The secret is a transistorized movement, no larger than a pack of cigarettes, which is powered by a single flashlight battery. Current drain is so small that the clock will run a whole year before the battery needs replacing.

Make the rack of walnut or other hardwood and assemble with white glue. The numeral positions are marked with dowels of a contrasting wood. The dowels are glued in holes drilled in the face. Let the dowels protrude slightly, and after the glue has set sand them flush with the wood face.

The movement may be purchased complete with hands from the Armor Co., P.O. Box 103, Station A, Flushing, N.Y. 11358. It costs $7, postpaid.



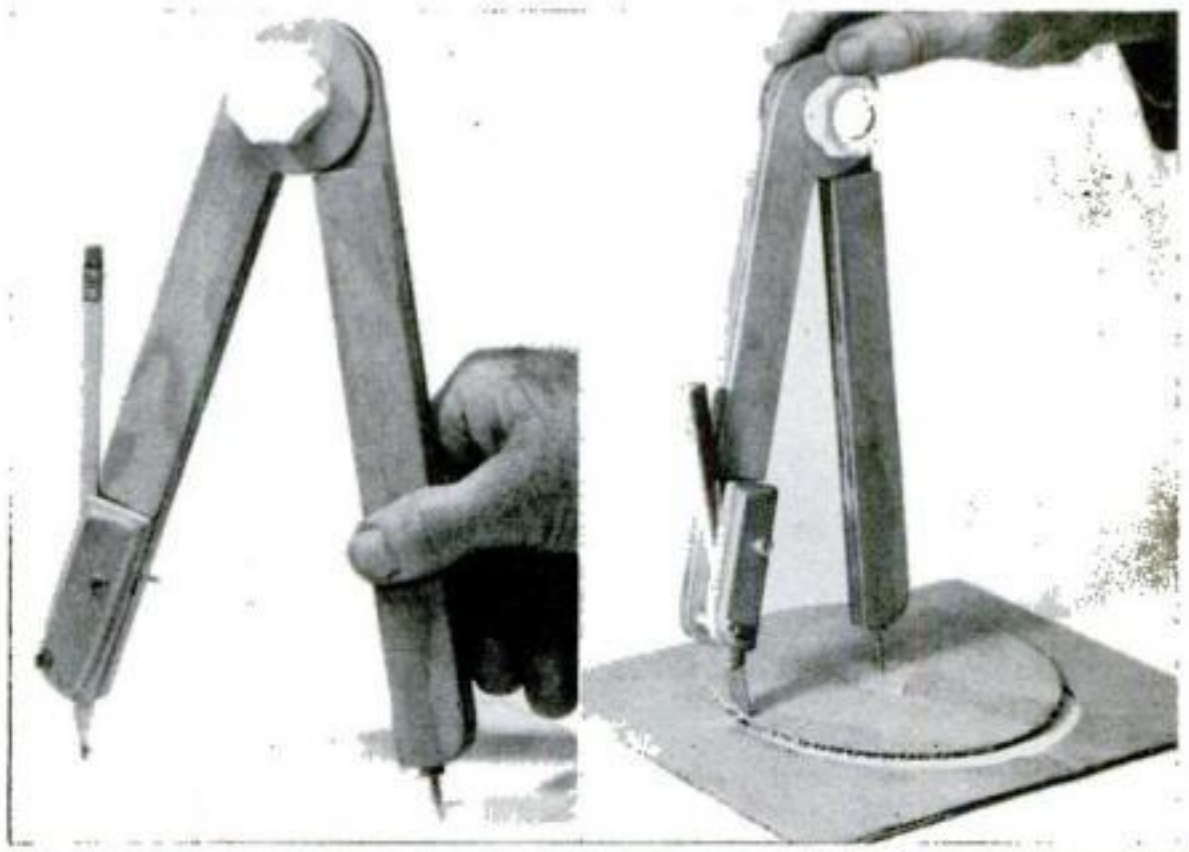
Urheberrechtlich geschütztes Material

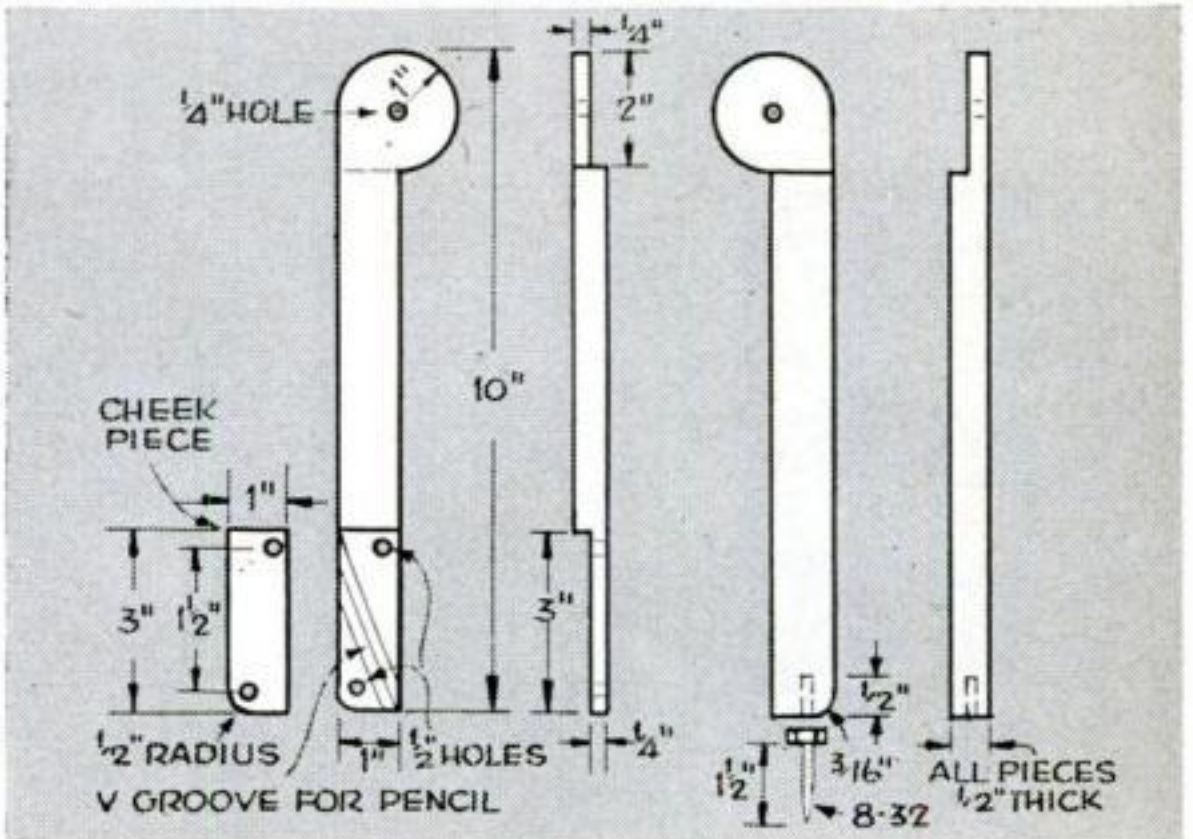
2 Accessories for Any Workshop

Giant Compass

DID you ever see a compass that draws circles from 1½″ to 2½′ in diameter, one so versatile that it can be used with a pencil, ballpoint pen, crayon, felt-tipped marker, modelmakers' knife, scribe, paintbrush, chalk, or glass cutter? Here's one. It's made out of three pieces of ½″ plywood cut out as shown.

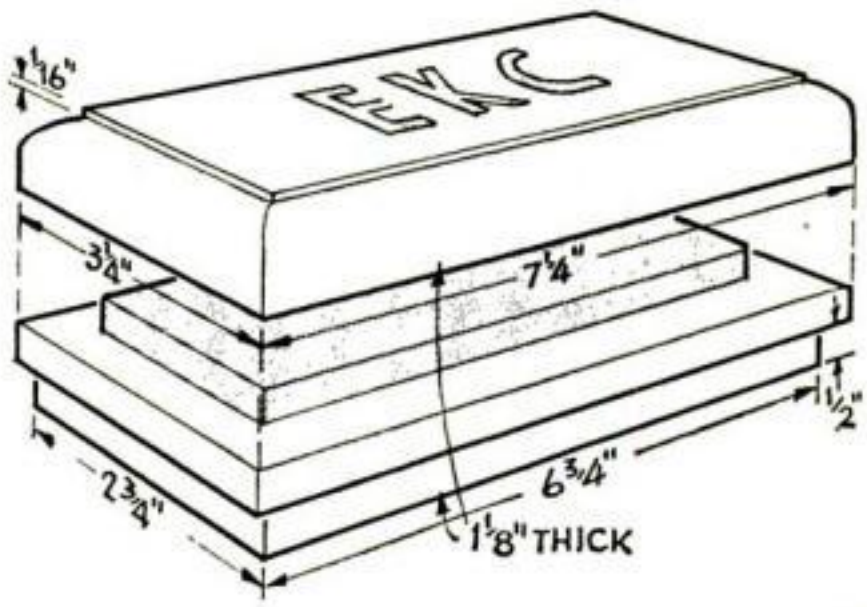
The shallow V groove in the pencil clamp is made with the edge of a four-corner file. The pivot point is made from a brass machine screw filed to a point while it is turning in a drill press. It's glued in place with epoxy. All the wood parts are coated with clear lacquer. The lock knob, a surplus radio part, is fastened with a setscrew to a piece of threaded rod. The threaded rod is screwed into a nut soldered to a flat washer so it won't rotate when the knob is tightened.—*Norman Fried, Los Angeles.*





Sharpening-Stone Case

FIVE-QUARTER stock is ideal for making this protective case for a sharpening stone, but you could also glue scrap wood together. The bottom edges are rabbeted so the base can be held in a bench vise to use the stone. A router is handy for cleaning out the well for the stone, but you can also do it with a chisel. Since my box was to be a gift, I inlaid initials in the top. I cut them with a ¼″ chisel and a knife. —*Peter K. Chase, Youngstown, Ohio.*



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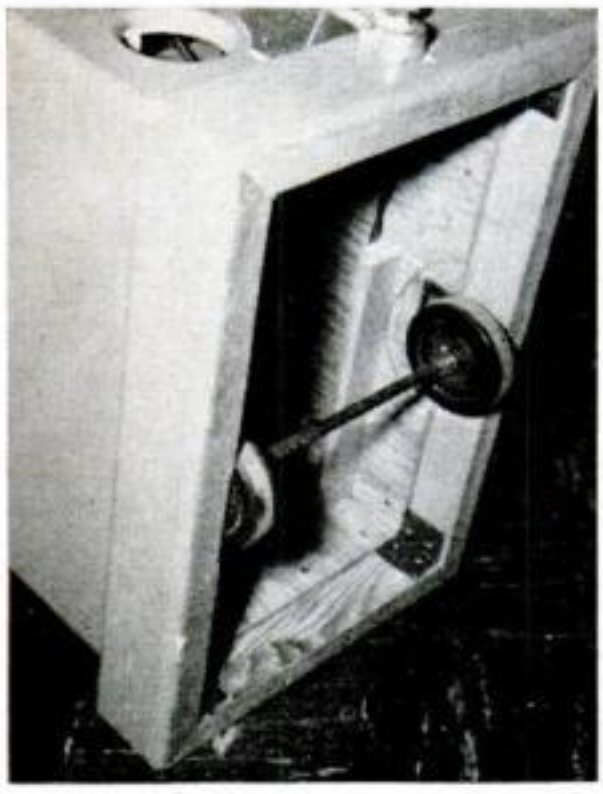
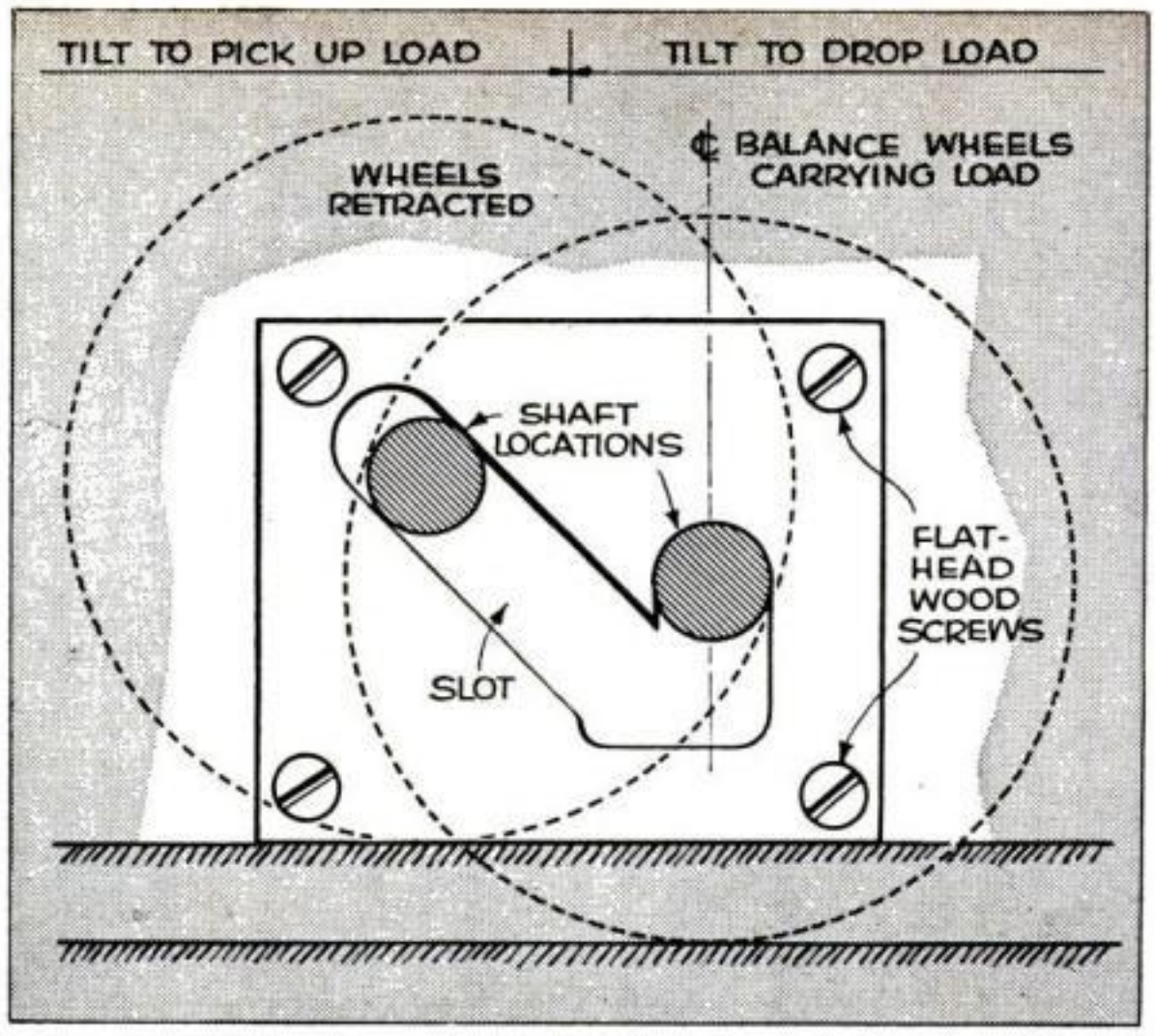
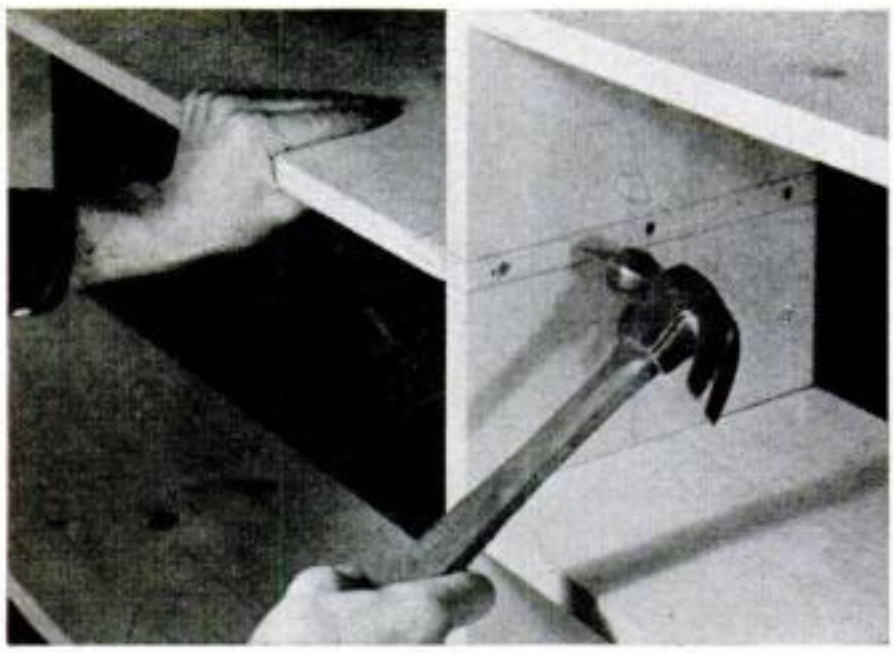
Short Cuts and Tips FROM PS READERS





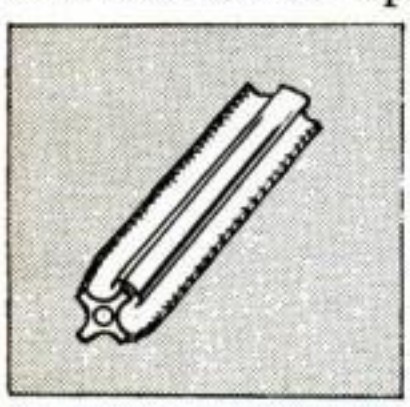
Retractable wheels move shop machines

These easy-to-install wheels make machinery easier to move around your workshop. You can use them on any piece of equipment that's not too heavy to be tilted. Fasten the slotted plates to the bottom of a machine after determining its center of balance by balancing it on a broom handle. *—J. Stanley Brown, Pittsburgh.*



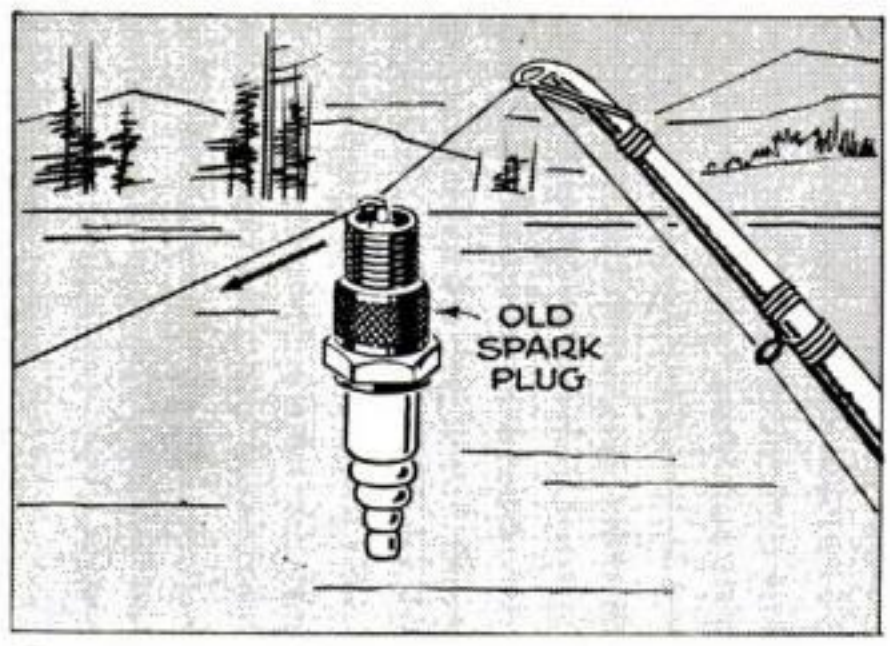
Threading an oversize nut

If the hole in a nut is slightly too large for a bolt, often the simplest way out is to put a shim in the nut and thread it. To do this, use a strip of shim or thin sheet-metal stock bent into a U shape. Fit this over one set of tap threads, with the legs of the U set into the flutes. Then tap in the normal manner, inserting the tap and metal shim simultaneously in the nut.—*Fred F. Davis, Vancouver, B.C.*



Stagger those shelves for end-nailing

Making utility shelves? You can save work by designing them so they don't meet the uprights between them at the same level. Stagger them (left) and all nailing becomes end-nailing, with maximum strength. *—Jackson Hand, Westport, Conn.*



Free snagged lures with old plugs

I don't lose my expensive fish lures anymore when they snag on the bottom. I take a discarded spark plug, bend the electrode over my line, and let it down. A few jigglings usually free the lure. You can get all the old plugs you want at any gas station.—*Jerry Cook, Addison, Ill.*

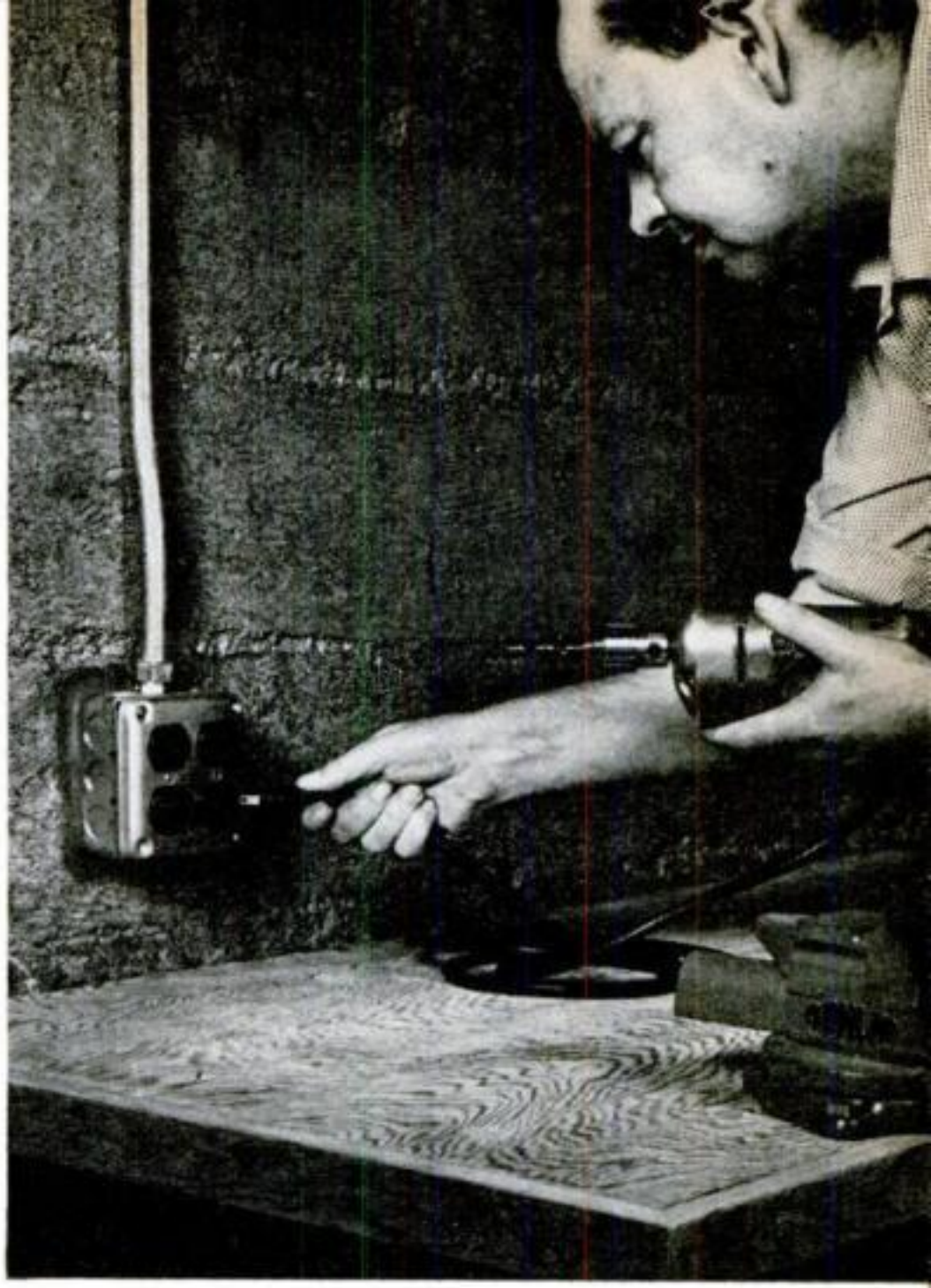
Urheberrechtlich geschütztes Material

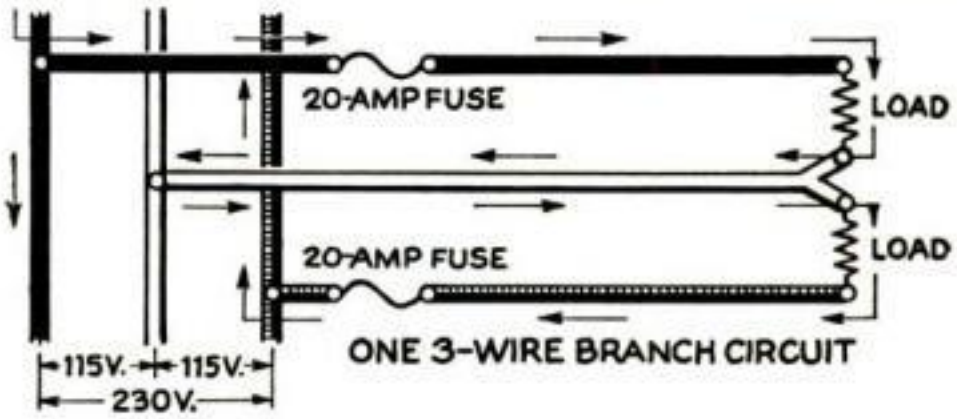
PS Money-Saving Series:

Improving Your Home Wiring

THIS MONTH: Wiring your home shop for power

By John Burroughs





Why a three-wire branch circuit? In situations where two two-wire circuits normally would run roughly parallel, it pays to substitute a single three-wire circuit, with each leg drawing 115 volts from opposite sides of a 230-volt service. This cuts installation costs by saving material and labor. When loads on the two legs are about equal, there's also a considerable reduction in voltage drop. It's a good idea to mount a multiple outlet behind the work bench as you see in the photo at top of page.

A SHOP area should have multiple-circuit wiring. You don't need a separate circuit for each tool, but the total load imposed by modern home-shop electrical equipment—all the power tools and area lighting fixtures you might use simultaneously—makes at least three circuits desirable.

One should supply only the lights. The other two, each with 20-amp capacity, should serve a convenient array of grounded outlet receptacles.

Why two outlet circuits? Because it's safer and more economical electrical practice to employ two or more 20-amp circuits to supply a large quantity of 115-volt power rather than a single high-amp circuit.

In most cases changing inadequate existing wiring to three-circuit wiring can be accomplished simply by (1) installing new circuits for outlets, and (2) reconnecting the existing circuit for lights only.

The two new outlet circuits, since they'll be running parallel from the service panel to the shop area, can be combined advantageously into a single three-wire circuit. Dividing the three-wire circuit at a junction box in the shop area will provide two-wire circuits to feed outlets on opposite walls of the shop.

Each leg of the divided three-wire circuit can supply 2,300 watts of power, or 4,600 watts total capacity at the outlets.

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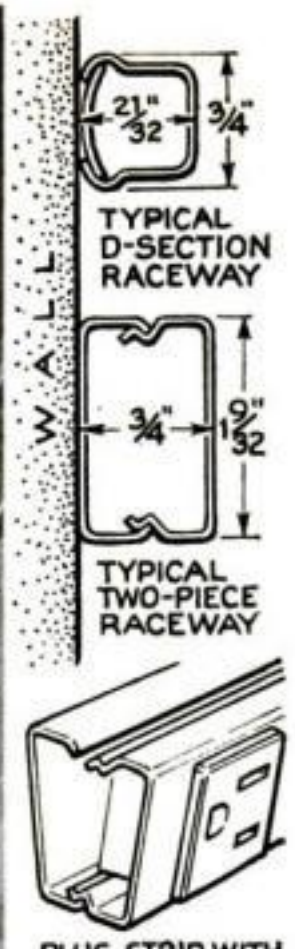
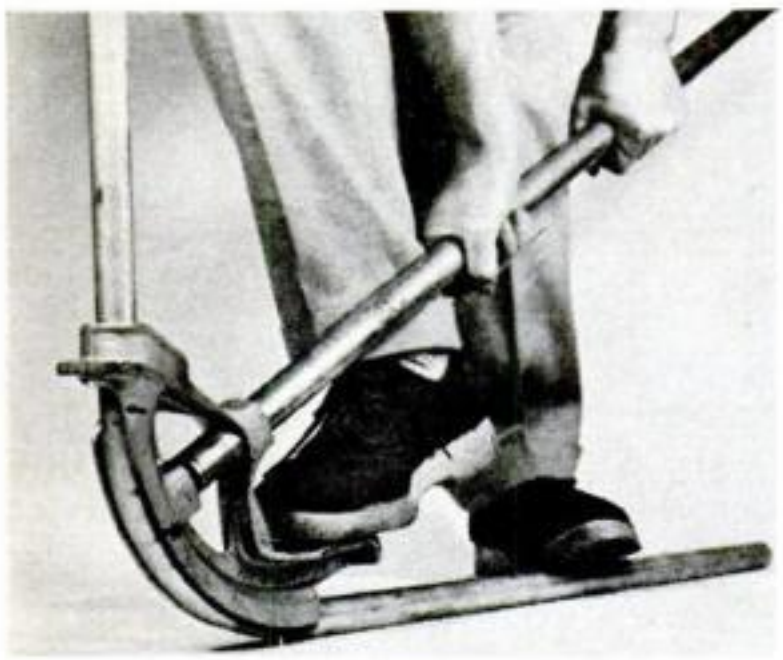
Urheberrechtlich geschütztes Material



Surface wiring in a home-shop area needs the protection given by one of the methods shown above. As seen in the photo, author installed a ¾" thin-wall conduit for a new three-wire shop-outlet circuit parallel to the existing conduit carrying the circuit serving lighting fixtures. Secure the conduit to the joists at least every 5' with the proper mounting straps.



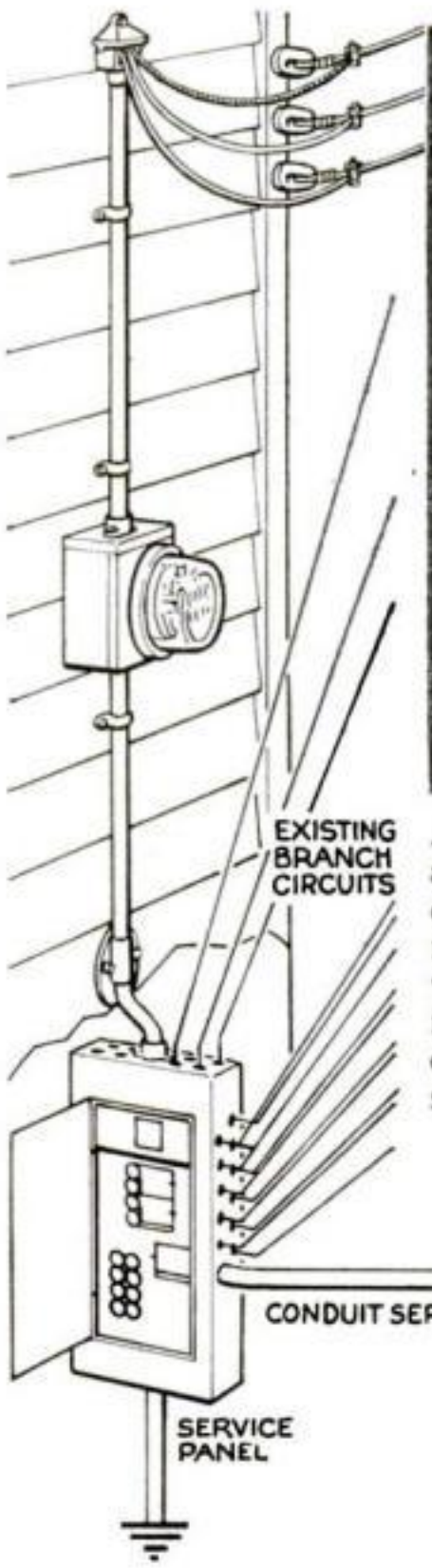
Borrow or rent a bending tool to make uniform bends in conduit. The electrical code sets a limit of four right-angle bends per run of conduit —from junction box to junction box.

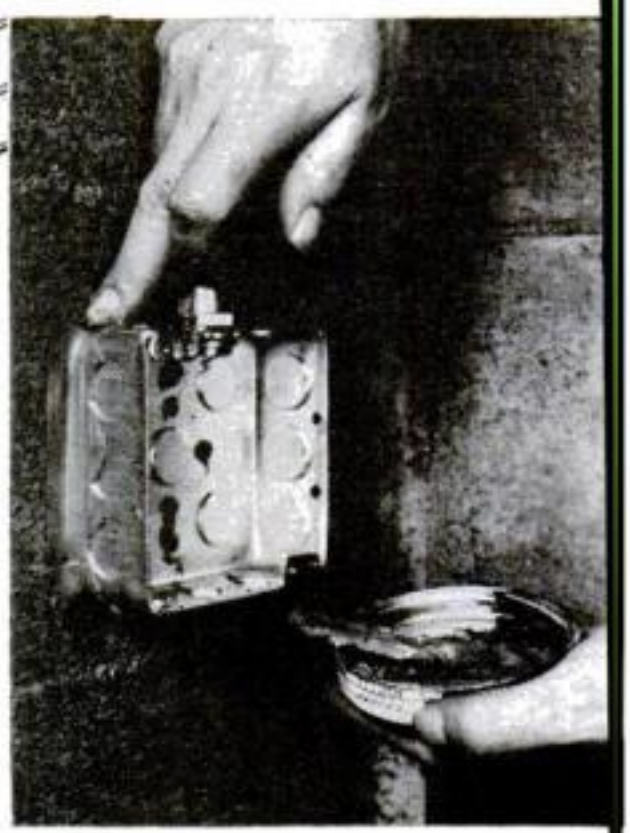
Number of conductors permitted in conduit

Size	Capacity
½" conduit	Up to 4 No. 14 wires
	Up to 3 No. 12 wires
	Only 1 No. 10 wire
¾" conduit	Up to 6 No. 14 wires
	Up to 5 No. 12 wires
	Up to 4 No. 10 wires

Any cord-and-plug power tool rated to 15 amps (1,725 watts) can be attached at any outlet. Machines drawing more than 15 amps and all fixed (permanently connected) power tools should have individual circuits. A 230-volt tool—an arc welder, for example—will require a separate circuit.

The new three-wire branch circuit probably can be connected to your home's 115/230-volt electrical service (the residential service standard virtually everywhere in the U. S.) simply by utilizing the service panel's unused fuse receptacles or circuit-





A fillet of epoxy cement around the base will secure a junction box to a masonry wall—or attach with screws. Be sure to install straight length of conduit before mounting second junction box.

NEXT MONTH
New and better switches

Urheberrechtlich geschütztes Material

breaker openings. Provided the panel isn't already overloaded, adding a three-wire shop outlet circuit won't necessitate installing a larger panel.

When using power in your shop you're generally not using as much power elsewhere in your home, and the new circuit therefore will add little extra load. If intermittently it should increase total household electrical consumption, the increase will be split between the main fuses on opposite sides of the 115/230-volt service. If you're adding new heavy-load tools, check with your power company to be sure your service entrance is husky enough.

If the service panel in your home has no unused fuse or breaker openings, installing an auxiliary circuit-breaker panel connected to the existing panel's power-take-off lugs will solve the problem.

The metal-enclosed wiring systems offer best mechanical protection in a shop. Conduit-wiring in a shop area is ordinarily very easy. You can simply surface-mount the conduit across joists and along walls.

Surface-mounted metal raceway, another choice, makes a somewhat more attractive installation in a finished basement. Two

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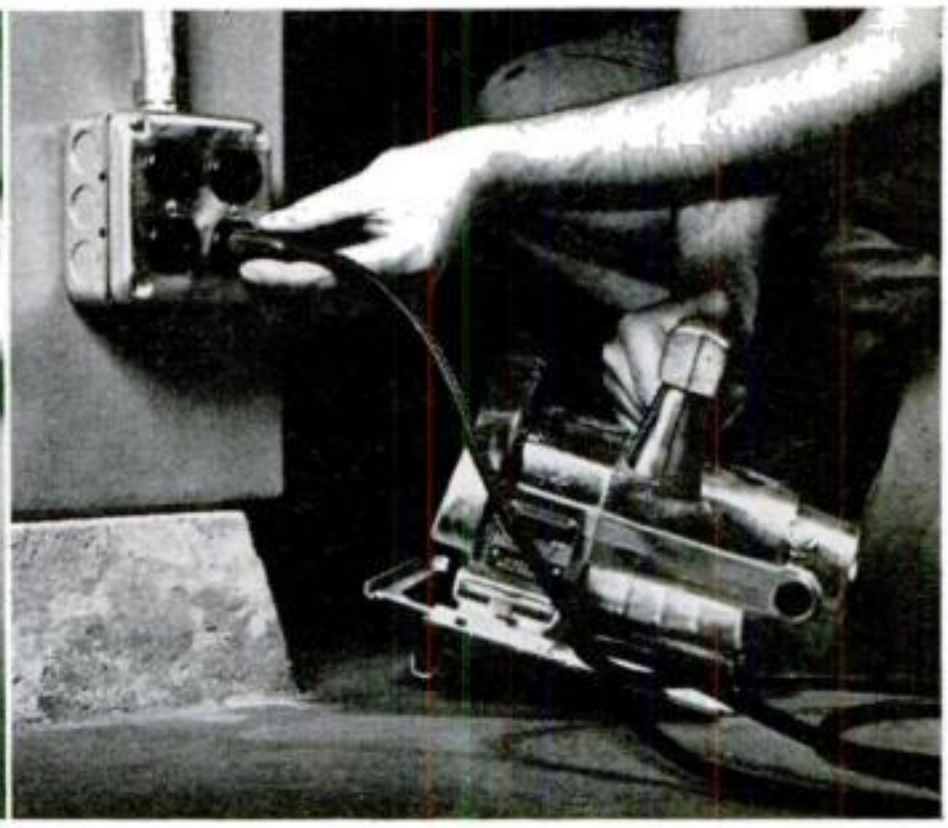
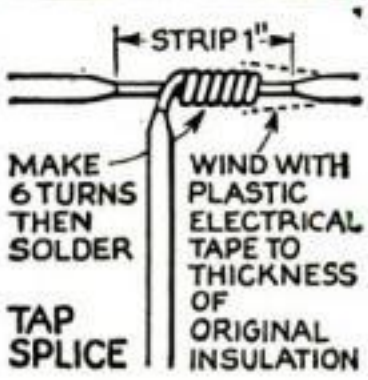
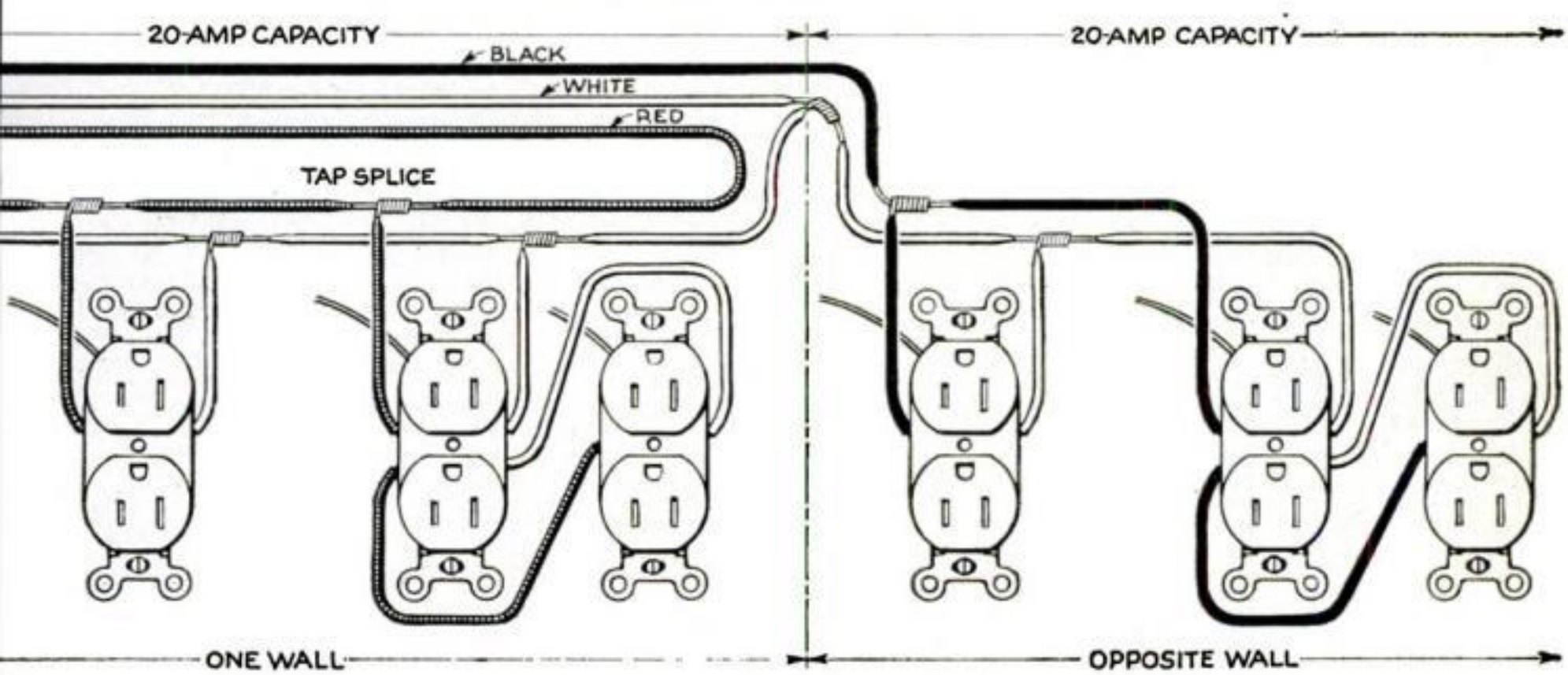


Soldered tap splice is the way to attach extra white neutral wire in box where you split up a three-wire circuit into two 115-volt ones. Continue the red wire and a white into one circuit, black and white in other.



Close-to-the-floor outlets are convenient for plugging in portable electric power tools. The code permits low outlets in basements, but in residential garages and adjoining areas where gasoline vapor could collect at floor level, wiring must be at least 18" above the floor. In any new electrical work, the code requires grounded receptacles for three-pronged plugs.



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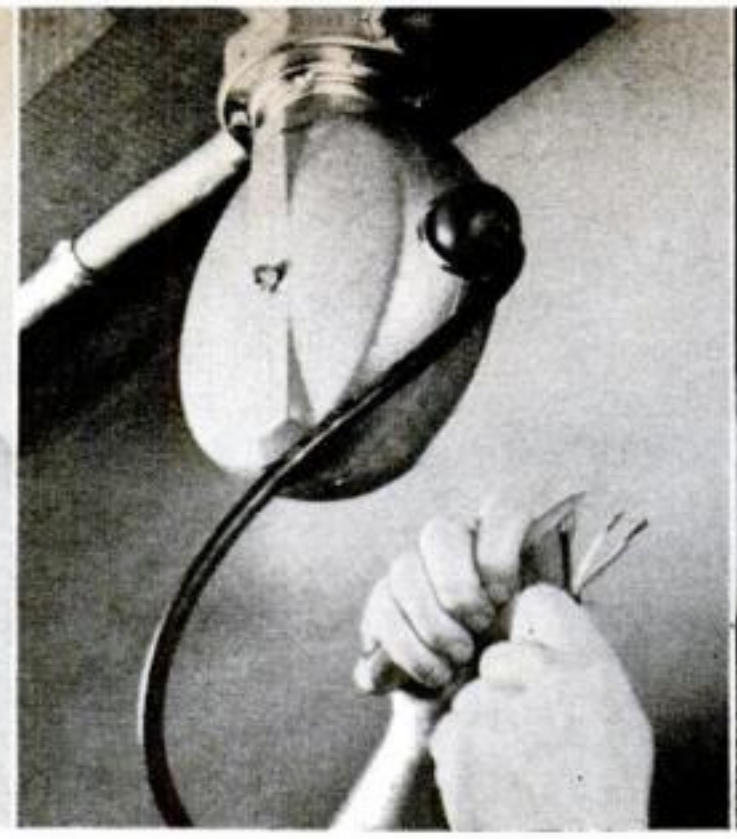
You can measure the illumination in your shop with any incident-light photographic meter. On meter shown, top scale indicates foot-candles. The pointer reads 50-60 foot-candles. This is the light level that experts say is desirable for benchwork.

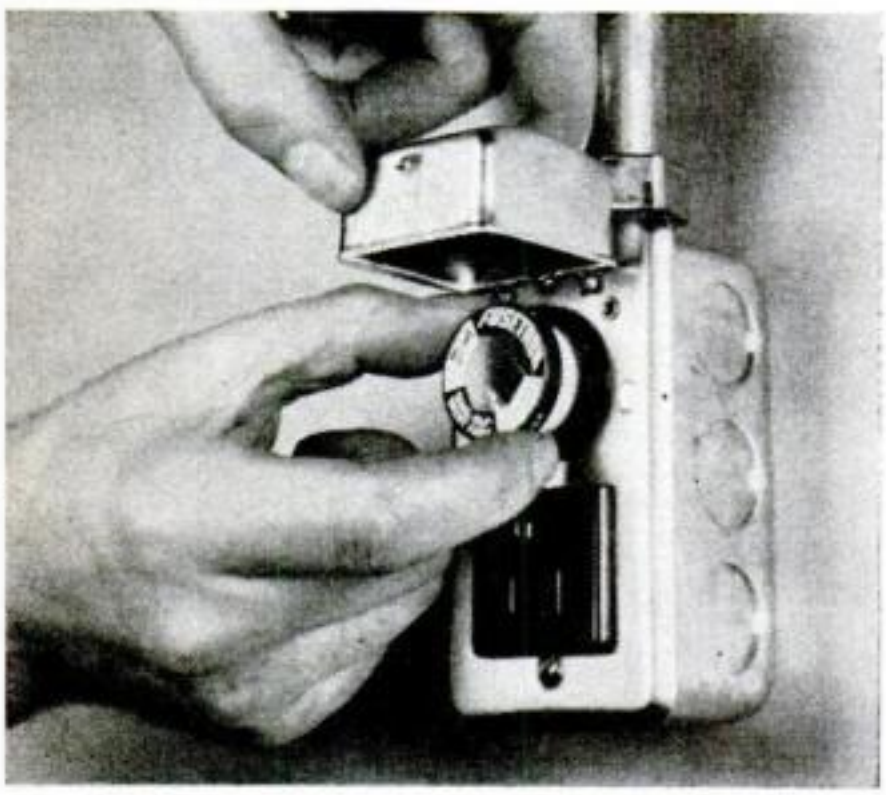


Retractable extension cord on a ceiling beam above center of large shop area is convenient for power and portable light. Unit shown (Appleton Electric) has swivel plate that fastens to a 4" box. The 20' cord ratchets like a window shade.

Installing a few reflectors is often an effective way to improve shop lighting without any wiring changes. An incandescent bulb in a white reflector gives nearly twice as much light as a bare bulb. Install 150-watt bulbs in reflectors.

types are available, each in various sizes. One kind is like conduit but D-shaped in cross section. Wiring is pulled into it after it's installed. The other kind is made in two sections that snap together. The base section is mounted, wiring laid in, then the cover snapped on. Special matching boxes are used with the D-sectioned type.

Flexible armored cable is also easy to install, and is available with three color-coded wires of the same size described further on for conduit. When wiring with cable remember two precautions. One, be sure to use fiber bushings to cover the ragged cut ends of the armor. The other, always be sure the bare grounding wire that runs under the armor is connected to the metal box. You can buy boxes with terminal screws for this purpose. Where local code permits, you can simply bend the wire back over the cut end of the armor so the cable connector grips it to make a grounding contact.



One outlet in your shop should have a time-delay (type S) fuse. Use of this is advisable when a shop motor without built-in overload protection is required for heavy work. The fuse rating should be ½ amp greater than the amp rating on the motor nameplate. The fuse will then protect motor windings, yet permit the motor to draw a heavy momentary starting current.

All wiring jobs must be installed in conformance with the National Electric Code, a handbook of safe electrical practice developed by insurance underwriters and in most communities adopted into law. Public libraries have copies. In most cities a home owner is required to obtain a permit before beginning work and to have the completed job checked by a city or utility-company inspector.

The three-wire branch circuit diagramed will meet requirements if you use standard materials and remember these points:

- Use due caution at the service panel. Pull the main fuses and check terminals with a test lamp to make sure the power is off before touching any connection.

Various kinds of fuse-type and breaker-type panels are in general use. Most have wiring diagrams inside. If you're not sure you understand your panel's 115/230-volt

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Fluorescent lamps provide soft, even illumination over a relatively broad area, produce three times the light for the current consumed, and last five times longer than incandescent bulbs. Two 40-watt fluorescents located at the ceiling above a bench will give about 60 foot-candles at work level.

Desirable lighting levels for shop work*

General illumination (foot-candles at work level):	
For storage areas	10
Rough benchwork, blacksmithing	25
Garage, general repairing	40
Power-tool work, drafting	50
Precision metalwork, model-making, furniture finishing	100
Supplementary illumination:	
Power-saw worktables	100-500
Arc welding, torchwork	1,000

*As recommended by the Illuminating Engineering Society.

wiring, don't guess-and-try. Call in an electrician and ask him to show you how to connect the three-wire branch circuit.

● When installing wiring in conduit, first mount the conduit and boxes, then insert the wires. Beginning at a knockout in the service-panel cabinet, run ¾" conduit to a 4"-square steel junction box in your shop area. Don't make more than four right-angle bends in conduit between boxes. Secure it every 5′ with a strap. To protect the wire insulation, the code requires that all cut conduit ends be reamed before installation. You can do it with a pipe reamer.

Next install ¾" conduit branching from the junction box and running along opposite walls of the shop near the ceiling. Extend these conduits to octagonal boxes mounted directly above outlet-box locations.

Use ½" conduit between the octagonal boxes and wall-outlet boxes. Electricians make shallow dogleg offset bends in the conduit near each box to make it hug the wall. Mount boxes for as many outlets as needed, installing at least one outlet for each 12 lineal feet of usable wall space. Wall outlet boxes ordinarily are mounted with centers 44" above the floor.

Fasten all boxes securely. Tighten all couplings and box connectors to insure electrical continuity in the conduit.

● Insert three No.-12-type TW wires color-coded red, black, and white into the conduit at the service panel and push them through to the junction box. If you can't push them through, pull them through with an electrician's fish tape. Use continuous lengths of wire.

At the junction box, tap-splice an additional white wire to the three-wire circuit's white leg, which will split the three-wire circuit into two two-wire circuits. Continue one two-wire circuit on into each of the conduits running along the shop walls. At the octagonal boxes, tap-splice wires to lead down to the outlet boxes, using No. 12 wire throughout.

● Use grounded-type duplex outlet receptacles (15-amp rated), wiring them in parallel. A ceiling receptacle near the center of the shop may also be handy as it lets you use power tools under it without trailing a cord all the way from the wall.

The accompanying diagram shows the two 115-volt legs of the three-wire circuit serving outlets on opposite sides of the room. In some communities electricians wire outlets on three-wire circuits with each duplex receptacle's top outlet sup-

[Continued on page 208]

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Lock-Up Workbench Protects Your Tools

Locked doors lessen the chances of injury to children. You can prevent rust damage, too

By Charles E. Rhine

YOU need a good supply of tools to keep a home shipshape. It's surprising how many tools you soon acquire and how fast your investment increases. The workbench you see on these pages will protect that investment. Locks on the doors keep tools secure from the hands of children in the family.

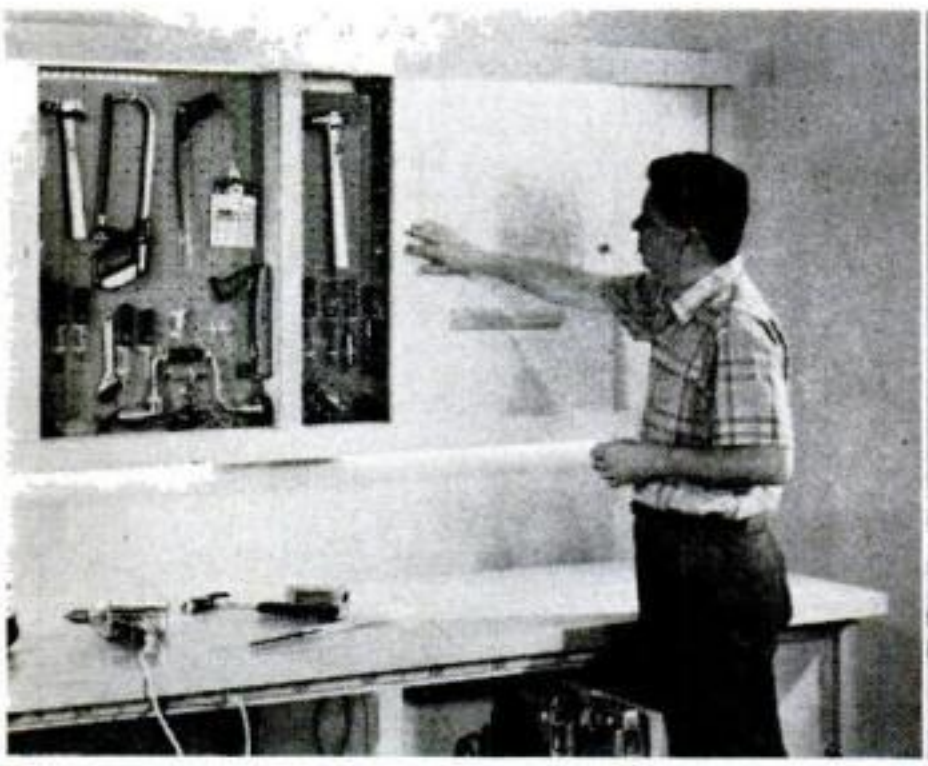
Storing all your tools behind doors also makes it easier to guard them against rust. A supply of drying agent inside each enclosure will absorb moisture and help the tools retain their gleaming factory finish.

But aren't those doors a nuisance? This was an objection brought up when we set out to design the bench. They aren't. If you want unhampered access to all the tools on the tool board, just lift out the doors and set them aside until you have finished your work project.

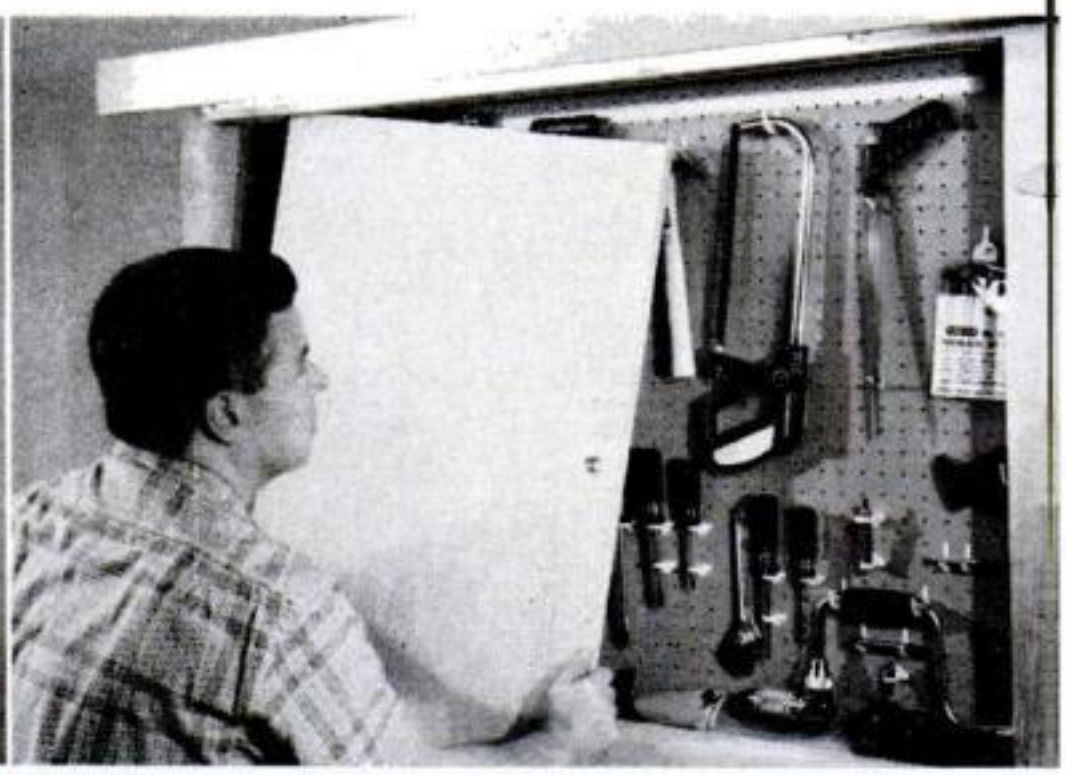
The workbench is easily built from materials you can buy at your local lumberyard and hardware store—plywood, two-by-fours, pine boards, perforated board, hardware, and electrical equipment.

The lock-up bench is part of an exciting new home-workshop concept developed in conjunction with The Stanley Works. The complete shop would consist of four modular units, each four feet long. It could grow along with your needs or interests and the space you have available. You can build it a unit at a time—or combine a couple of the units into a single structure.

The plans offer the builder many choices. In this article, the drawings show how to build the workbench in two sections, Unit A and Unit B, but you can build it as a single unit as shown in the photos. You can make it with the work surface at 30", 32", or 34",



Locking cabinet doors keeps tools safe in their place, and out of the hands of children.



Lift out doors and set them aside to get unhampered access to all the tools in the cabinet.

Urheberrechtlich geschütztes Material

depending on your height and how you will use the bench.

The drawings show how to slim down the cabinet under the work surface of Unit A to give knee room for a sit-down bench. The photos show the prototype cabinet full depth. To make this, take the front-to-back dimensions from Unit B.

You can also install sliding or swinging doors on the base cabinet of Unit A. But leaving it open provides convenient storage for lumber scraps, a pair of folding workhorses, or a portable toolbox.

In Unit B, you can install a simple adjustable shelf as suggested in the drawings —or build in a pullout storage shelf for por-

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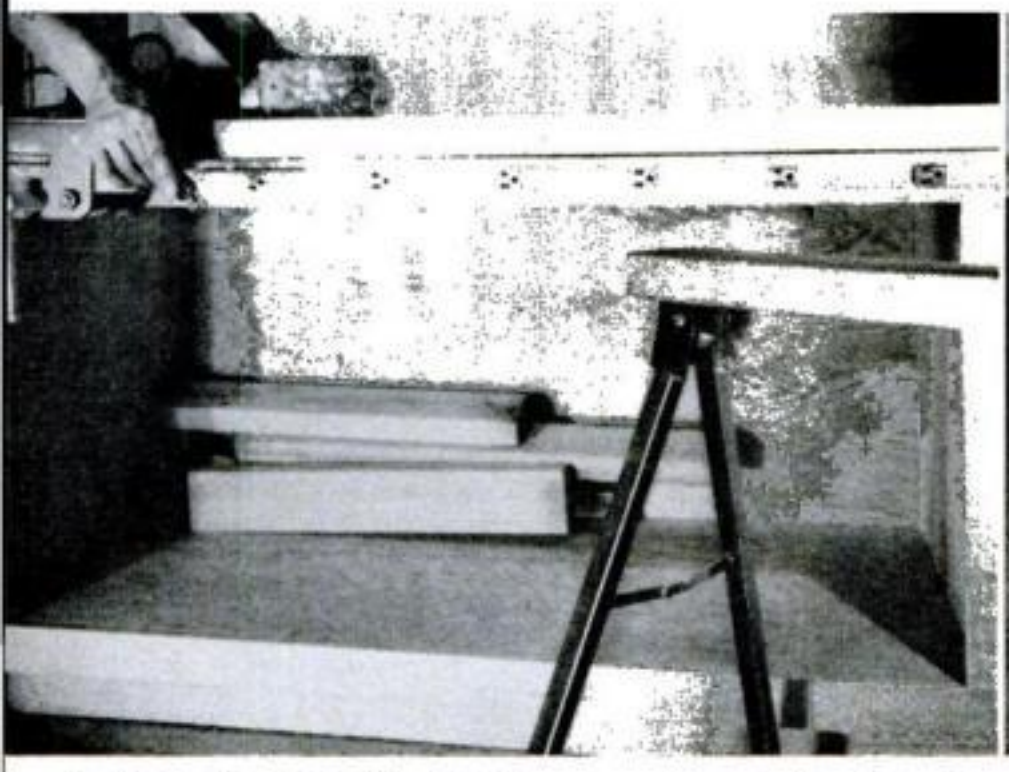

Storage space for lumber scraps, a pair of workhorses, or a toolbox is built into one unit.

Pullout storage shelf for portable power tools can be built in to keep them neat and handy.

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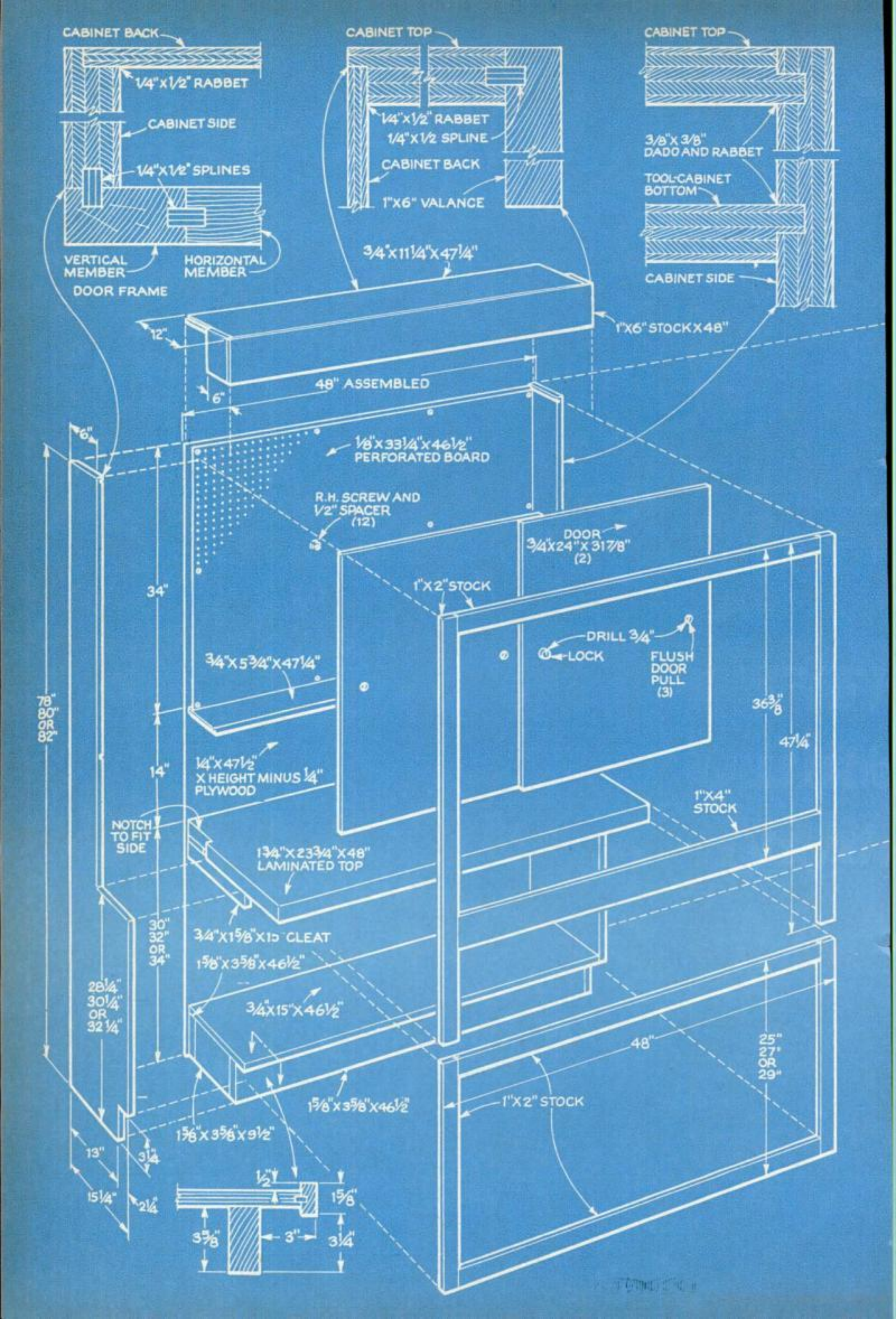
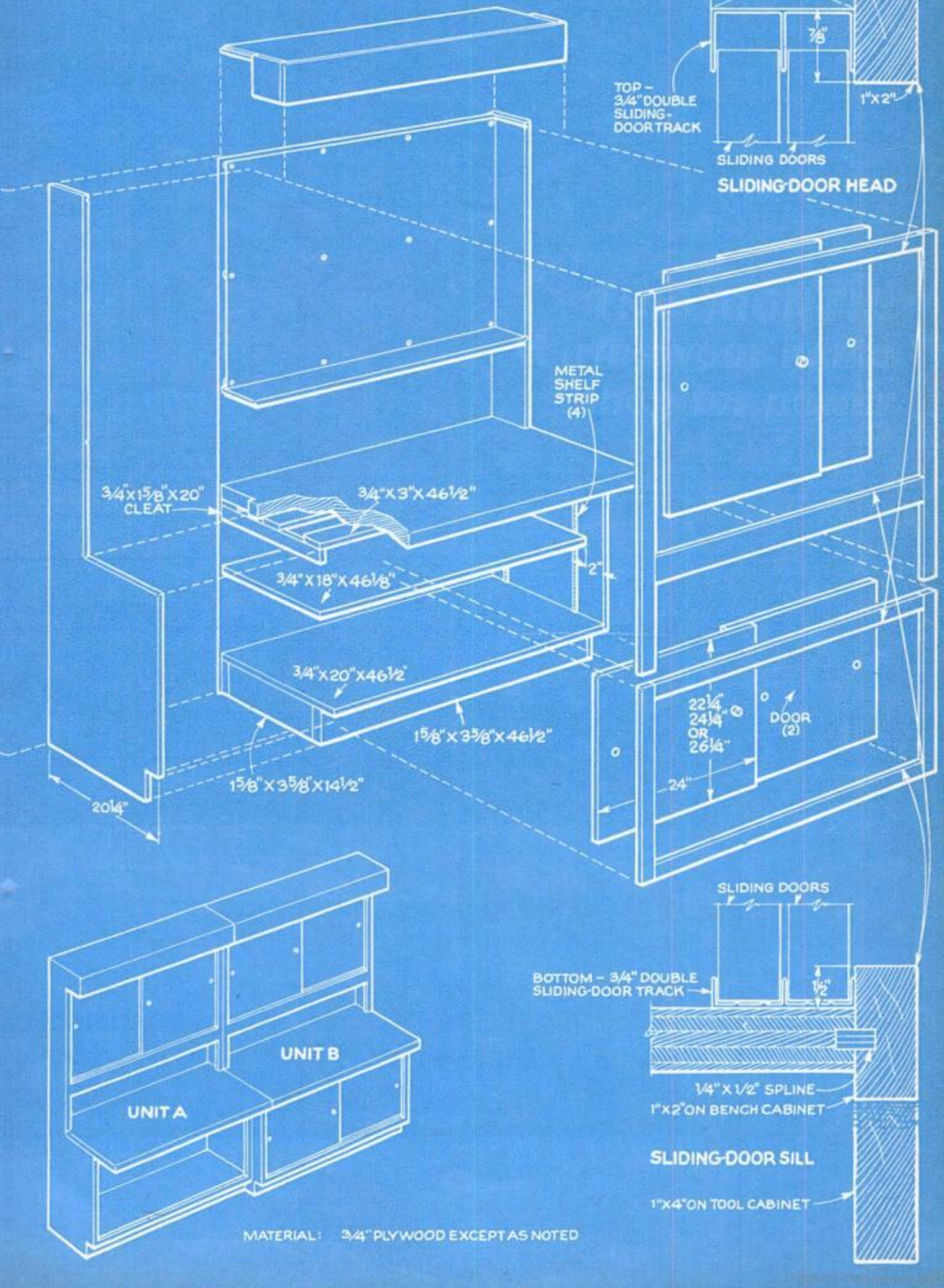
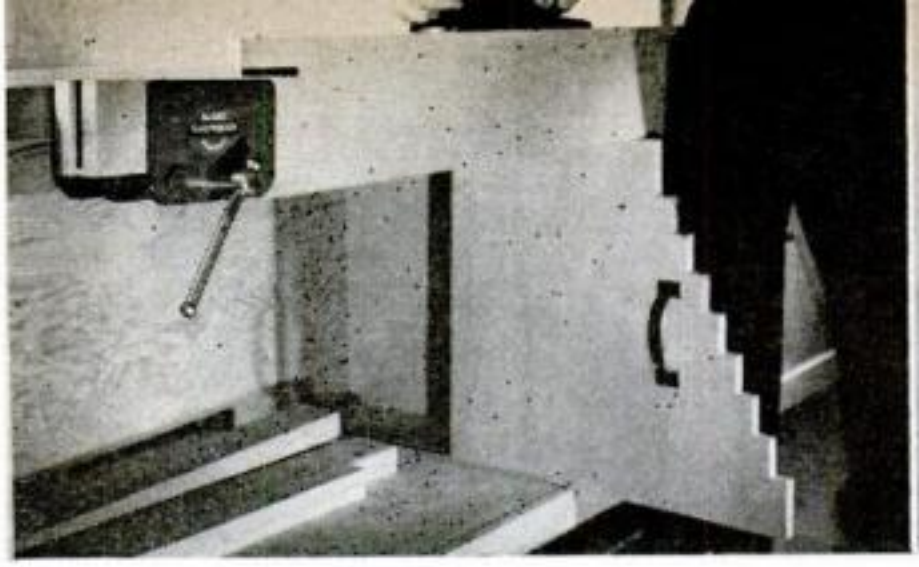

CABINET BACK
1/4"x1/2" RABBET
CABINET SIDE
1/4"x1/2" SPLINES
VERTICAL MEMBER
HORIZONTAL MEMBER
DOOR FRAME
CABINET TOP
1/4"x1/2" RABBET
1/4"x1/2 SPLINE
CABINET BACK
1"X6" VALANCE
CABINET TOP
3/8"X 3/8" DADO AND RABBET
TOOL-CABINET BOTTOM
CABINET SIDE
3/4"x11 1/4"X47 1/4"
1"X6" STOCK X 48"
12"
48" ASSEMBLED
6"
6"
1/8"x33 1/4"x46 1/2" PERFORATED BOARD
R.H. SCREW AND 1/2" SPACER (12)
DOOR 3/4"X24"X31 7/8" (2)
1"X2" STOCK
34"
DRILL 3/4"
LOCK
FLUSH DOOR PULL (3)
3/4"X5 3/4"X47 1/4"
78" 80" OR 82"
36 3/8"
47 1/4"
14"
1/4"X47 1/2" X HEIGHT MINUS 1/4" PLYWOOD
1"X4" STOCK
NOTCH TO FIT SIDE
1 3/4"X23 3/4"X48" LAMINATED TOP
30" 32" OR 34"
3/4"X1 5/8"X15" CLEAT
1 5/8"X3 5/8"X46 1/2"
28 1/4" 30 1/4" OR 32 1/4"
3/4"X15"X46 1/2"
48"
25" 27" OR 29"
1 5/8"X3 5/8"X46 1/2"
1"X2" STOCK
1 5/8"X3 5/8"X9 1/2"
13"
3 1/4"
15 1/4"
2 1/4"
1/2"
1 5/8"
3 5/8"
3"
3 1/4"

Complete Plans for Building the Lock-Up Workbench

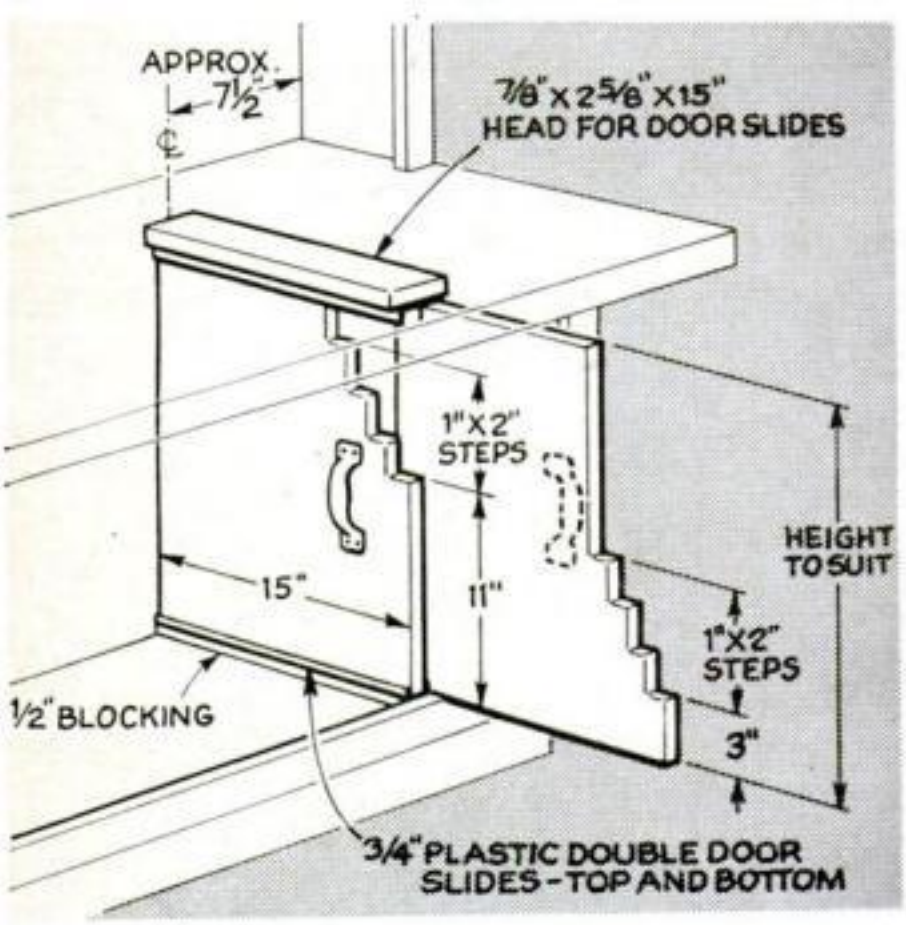


MATERIAL: 3/4" PLYWOOD EXCEPT AS NOTED

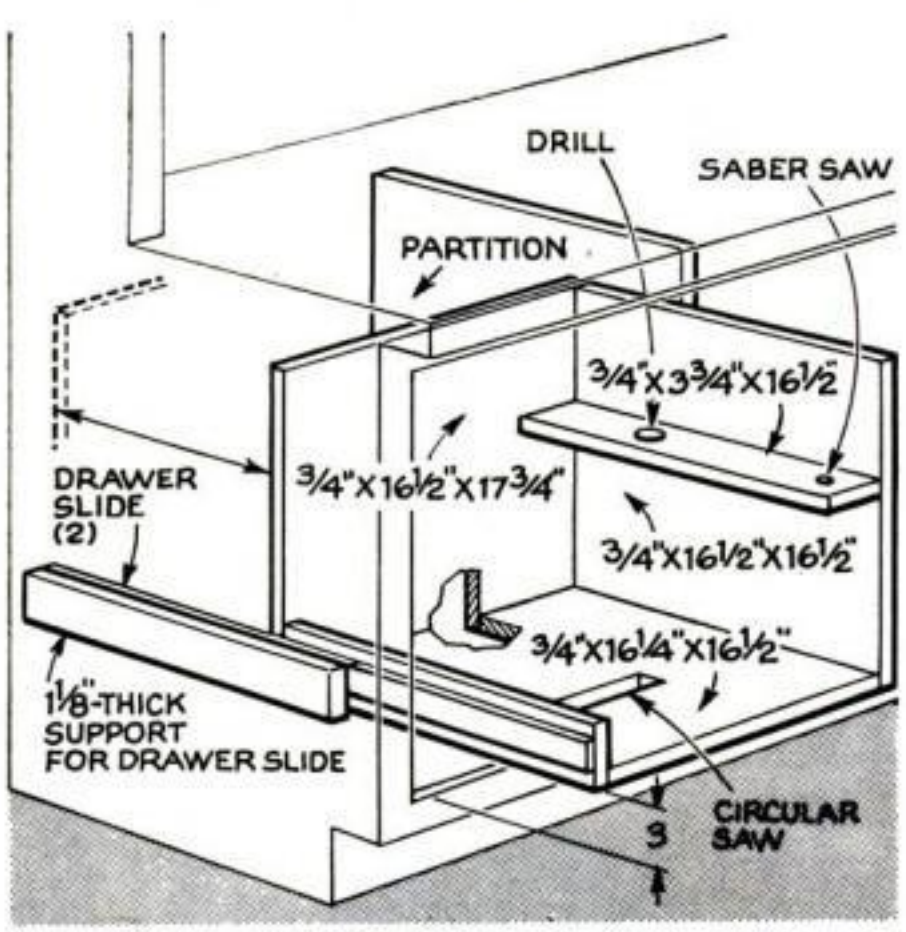


Optional features you can add to the workbench

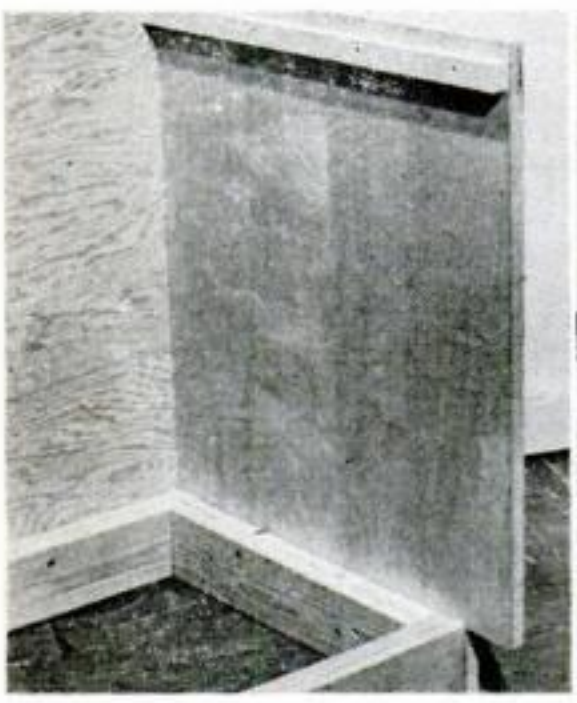
Build a vise work-support to help hold large stock. Make it in one piece, as above, if the bench has a full-width storage area; out of two pieces, as in the drawing below, if the bench has a knee-room recess. On the outer sliding door mount a magnetic tool bar that you can buy at a hardware store. It keeps tools off the work area, yet in easy reach.



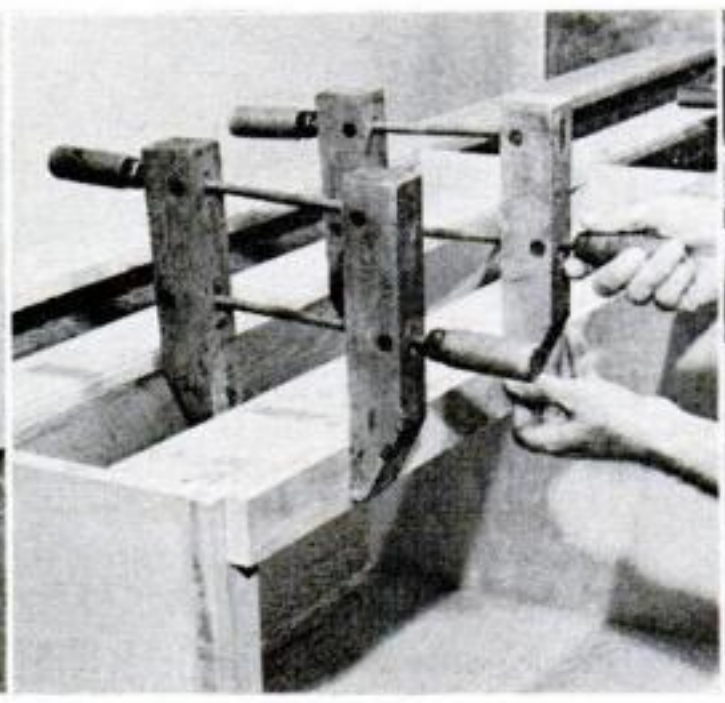
Work support consists of two ¾" plywood panels with 2"-deep notches. It's mounted on sliding-door track. Pull out one panel to work with narrow stock: the other for wide pieces.



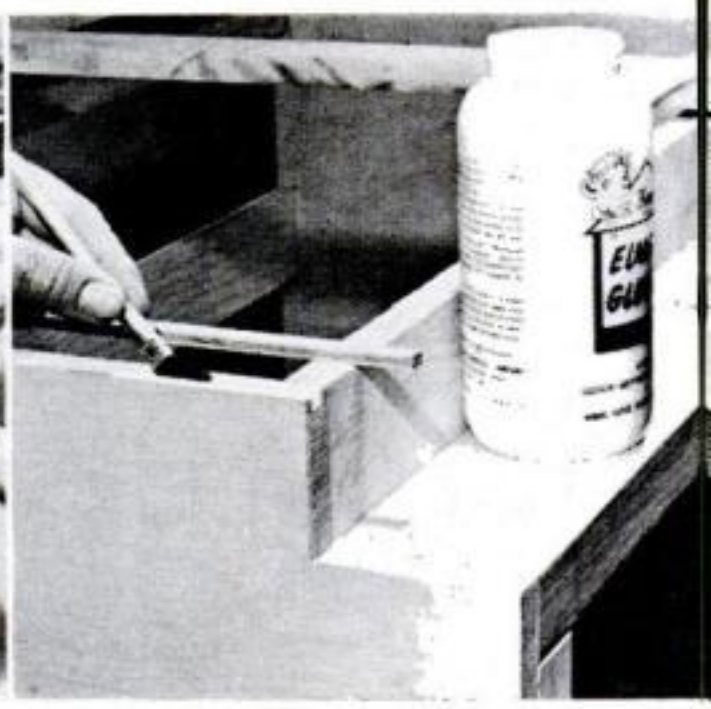
Pullout storage shelf for portable power tools is made from a 4'-by-4' sheet of ¾" plywood, a strip of clear pine, and drawer-slide hardware. It's assembled with glue and finish nails.



Construction is similar to that found in kitchen cabinets. The base is made of two-by-fours; the rest is mostly plywood. This eliminates the need for bulky frames that take up space.



Put plywood strips between cleats on each of the side panels. Drive screws up through these strips to hold the bench top in place. Glue and clamp all joints, and nail or screw them.



Splined joints give added strength to the cabinet trim, and leave trim unmarred by nail- or screw-heads. Grooves for the splines are easily made with a router fitted with a ¼" bit.

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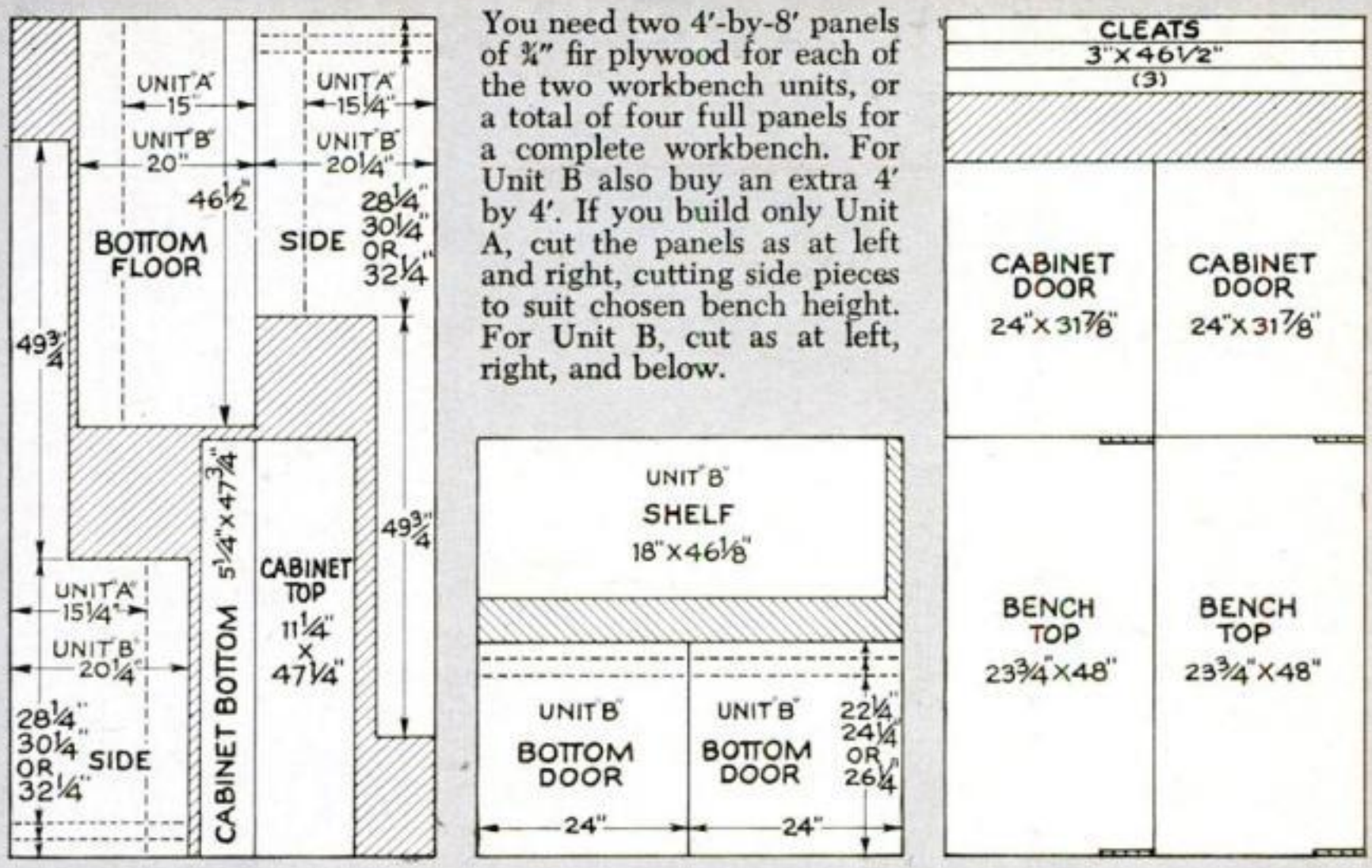
How to cut the ¾″ plywood panels for the workbench



You need two 4′-by-8′ panels of ¾″ fir plywood for each of the two workbench units, or a total of four full panels for a complete workbench. For Unit B also buy an extra 4′ by 4′. If you build only Unit A, cut the panels as at left and right, cutting side pieces to suit chosen bench height. For Unit B, cut as at left, right, and below.

table power tools, one of the most practical ways we've seen to store such tools.

A plug-in strip under the front overhang makes it easy to connect power tools, and keeps cords off the workbench. Put the plug-in strip across one end of the cabinet if you build Unit A with knee-room setback.

There is space on each 4′ workbench for mounting two 30-watt fluorescent lights—one behind the valance above the tool board, one under the tool board.

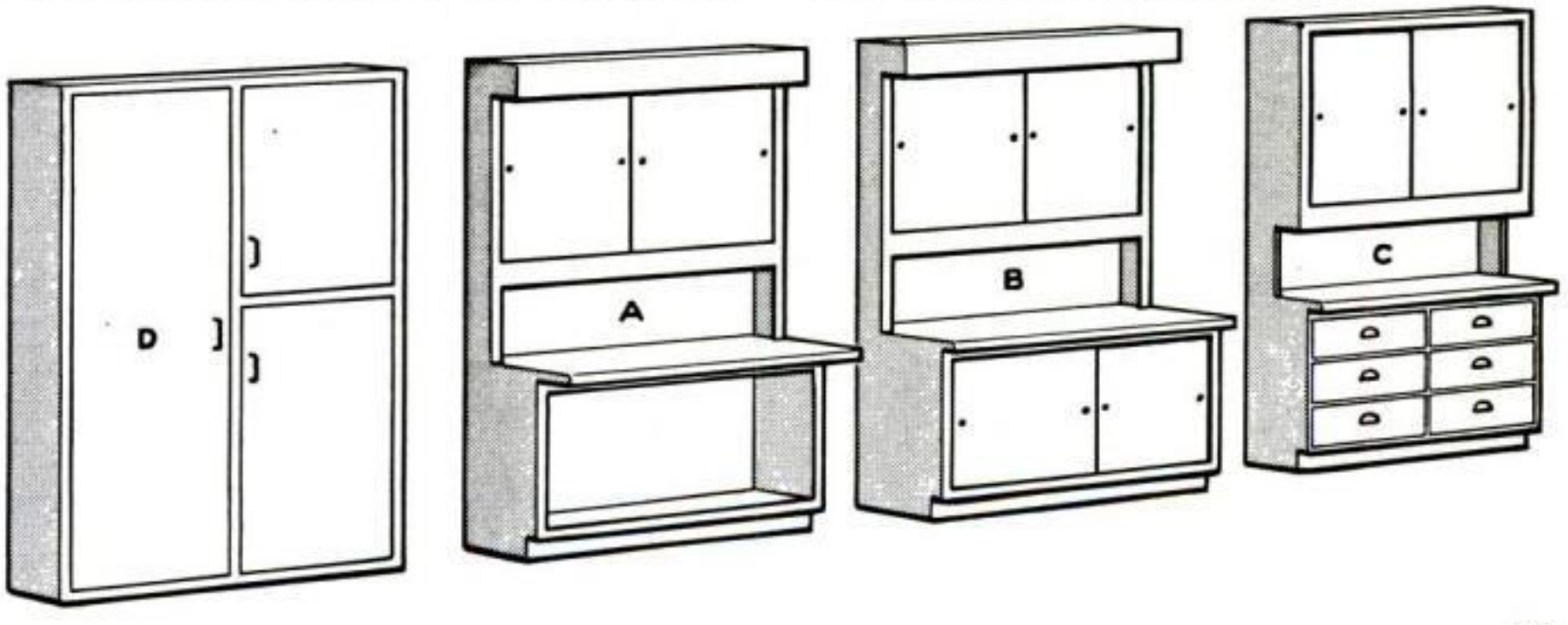
Most workshops are in basements or garages that are often damp. With this workbench you can keep your tools dry and rust-free by storing a container of silica gel or other drying agent in each compartment. Seal the compartment by cementing weatherstrip along the closing edge of the inner sliding doors so that it bears against the outer doors.

For lowest cost, build the bench of fir

[*Continued on page 206*]

The lock-up workbench is part of a shop that grows

For a complete workshop you might want to build four modular units such as these. The two center units make up the lock-up workbench described in this article. Unit at right, a cabinet for additional tools and supplies; at left, a storage cabinet. Build the workbench first.



Urheberrechtlich geschütztes Material

Personal-use report: How Good Are

By Harry Walton

HARDLY anybody uses two power tools at the same time. So why, went some daring thinking at General Electric, should each have its own motor—a part that accounts for at least half the cost?

Why not a master motor to which you can attach different power tools, one at a time—the same way you use them?

This sounds okay, but how does the idea work out? Fine. I tried pilot models of all the new GE tools that were announced in late summer. Except for minor squawks (probably corrected before the tools hit the market) I found them mighty satisfactory. Each one bolts to the motor as if for keeps, making a powerful, well-balanced drill, sander, or saber saw, geared for its job.

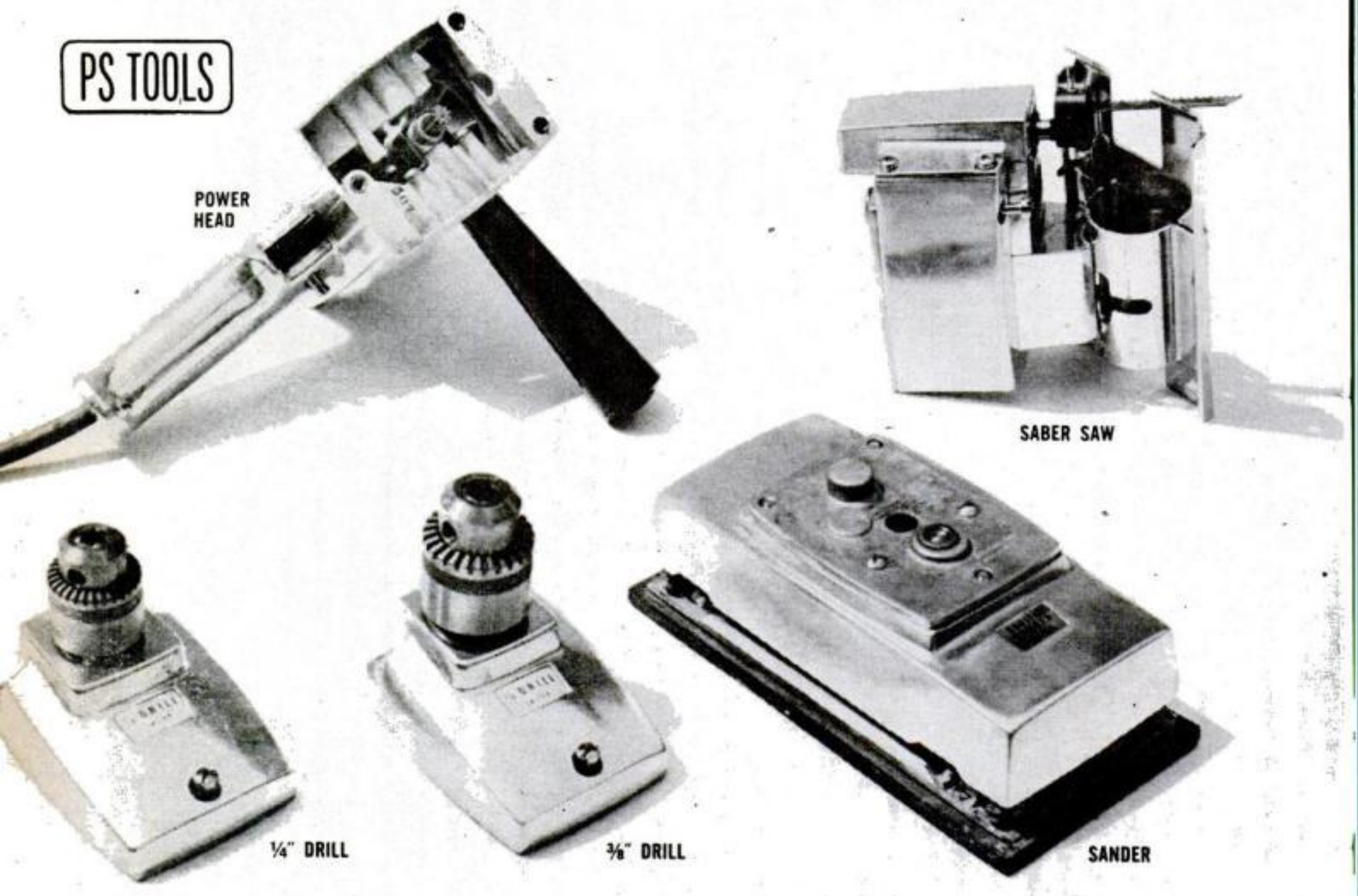
For fast straight sawing, GE also offers a powerful new 7" circular saw weighing only 10 lb. Cutting depth at 90 degrees is ⅜" to 2⅛", at 45 degrees, ¼" to 2"—enough to miter a two-by-four.

Rated for industrial use, the saw handles nicely, runs without disturbing vibration. I cut through a 12"-wide, 1⅜"-thick pine plank in five seconds. The saw sliced off sections only ⅛" thick with ease—good testimony to its smoothness and tracking ability. The blade guard swings back so smoothly you hardly know it's there, unlike some that stumble on the work edge as you start a cut.

The convertible-tool power unit is a ⅓-hp. GE motor with burn-out resistant windings, weighing three pounds. Tools and motor are listed for industrial use by the Underwriters Laboratories.

The business end of the motor has three tapped holes for mounting the tool heads, in which the bolts are permanently retained. There's no fumbling for loose bolts. Changing tools takes about 45 seconds.

Tool-head mechanisms are completely enclosed except for a hole through which the motor pinion passes. A shoulder on the motor bearing aligns gears so well that meshing is almost automatic.



Urheberrechtlich geschütztes Material

GE's New Power Tools?

The ¼" drill head weighs one pound. A two-stage reduction gear drives its Jacobs chuck at a no-load speed of 1,800 r.p.m.—about right for high-speed drills up to 3/16" working in steel, or bigger ones in wood and plastic, as well as disk-sanding, grinding, and polishing.

This tool drilled a ¼" hole through 1⅜" fir in 1½ seconds, the same thickness of hard maple in five seconds. Bearing down on a 1" power auger bit overheated the bit but not the motor. Nor could I stall the drill with this bit in oak or maple. A good 1" spade bit went through these hardwoods even faster.

The ⅜" drill—1¼ pound—runs at 900 r.p.m. (a good speed for some wood bits, ¼" and larger twist drills, and masonry bits). Its Jacobs chuck opens from 1/16" to ⅜". The tool didn't stall under the severe load of a 1¼" self-feeding bit boring through fir. A 2" self-feeding bit proved too much for it (as it has for other ⅜" drills tested). The tool stalled but did not blow a 15-amp fuse carrying a 300-watt-lamp load besides.

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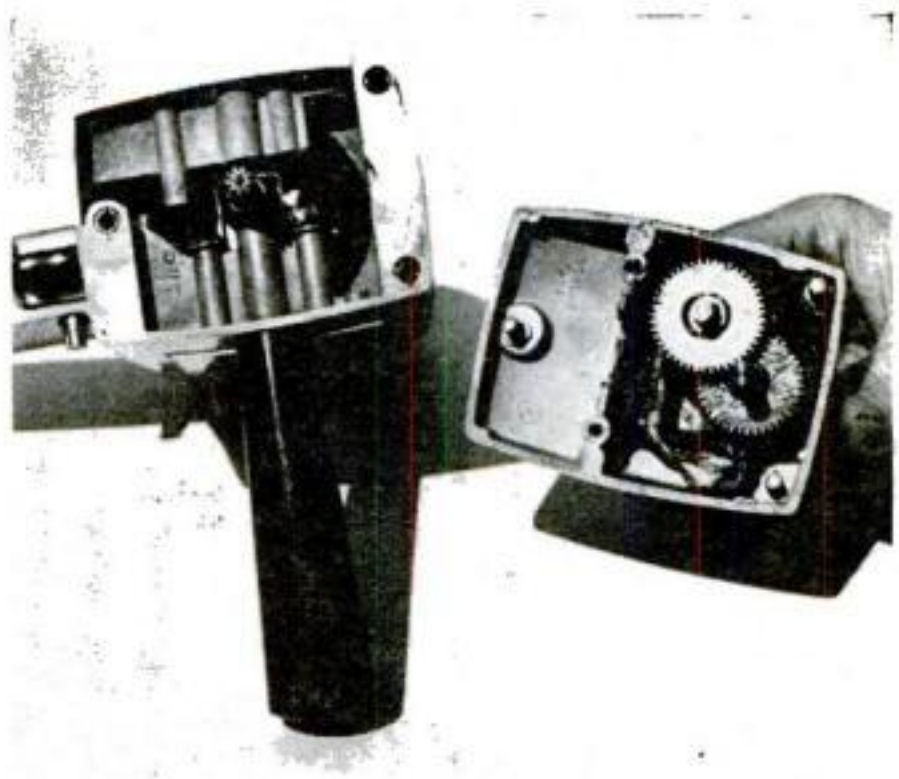
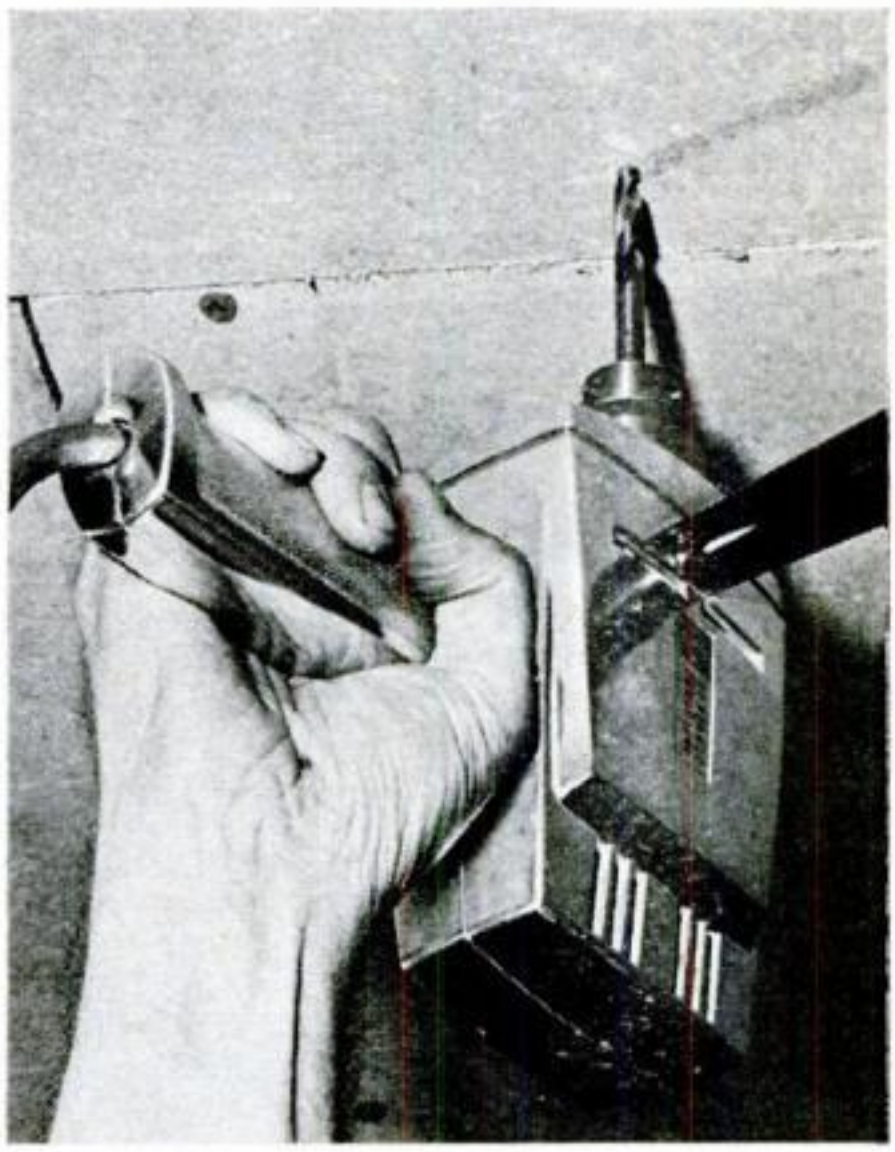
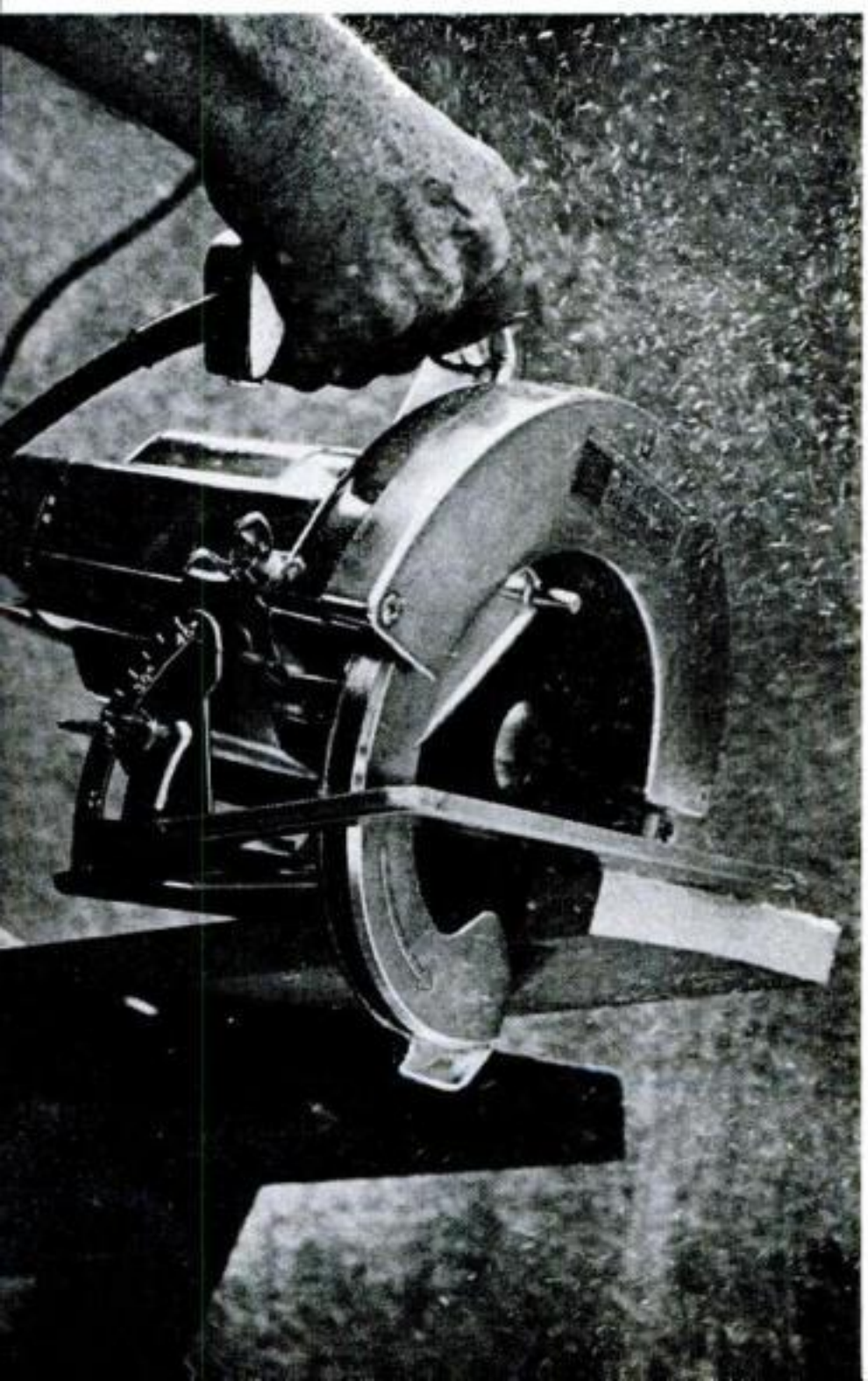


Motor shaft for convertible tools ends in a heat-treated, impact-resistant pinion (left) that engages the gears in the tool head (right). These are of special steel ¼" thick. Tool heads have a cover plate (not shown) to seal out dirt.



Motor handle is located at the center of gravity. Tools balance nicely in any position; even overhead drilling is not unduly awkward or tiring. A helper handle can be screwed in at either side or on top of the motor unit.



All of GE's new tools are lined up at the left—four that are used with a single power head and, immediately at left, a separate 7" portable circular saw. The saw motor puts out up to 1⅛ hp., and is industrially rated at nine amp. Both cutting-depth and tilt adjustments work easily. A large clearly marked scale shows the blade tilt.

Urheberrechtlich geschütztes Material

The orbital sander head—two pounds—makes 4,000 orbits of 3/16″ diameter per minute. It's claimed the machine is designed for minimum vibration to lessen user fatigue. To check that, I put the same paper on it and on another famous-make sander of the same size. The GE did prove easier to maneuver, less jangling to wrist and nerves, yet it removed stock as rapidly as the other. In fact, where the other machine had to be pushed, the GE seemed to glide.

On scrap pine with knotty sections, brief sandings with first 100 and then 220 paper produced a silky surface. The only beef I have about the sander is that the paper might be easier to mount if the skirt overhung less.

The saber saw makes 3,300 strokes of ⅞″ length per minute, weighs two pounds three ounces, takes a standard ¼″ blade. The shoe (or table) tilts 45 degrees in either direction for bevel cuts, retracts to permit sawing within ¼″ of walls.

Although it vibrates as much as any single-speed saber saw, the GE performs well. It cut through a 2″ oak plank with comparative ease. Balance is good, the handle comfortable. Plunge cuts (sawing without a starting hole) can be made with the blade in any of its three positions.

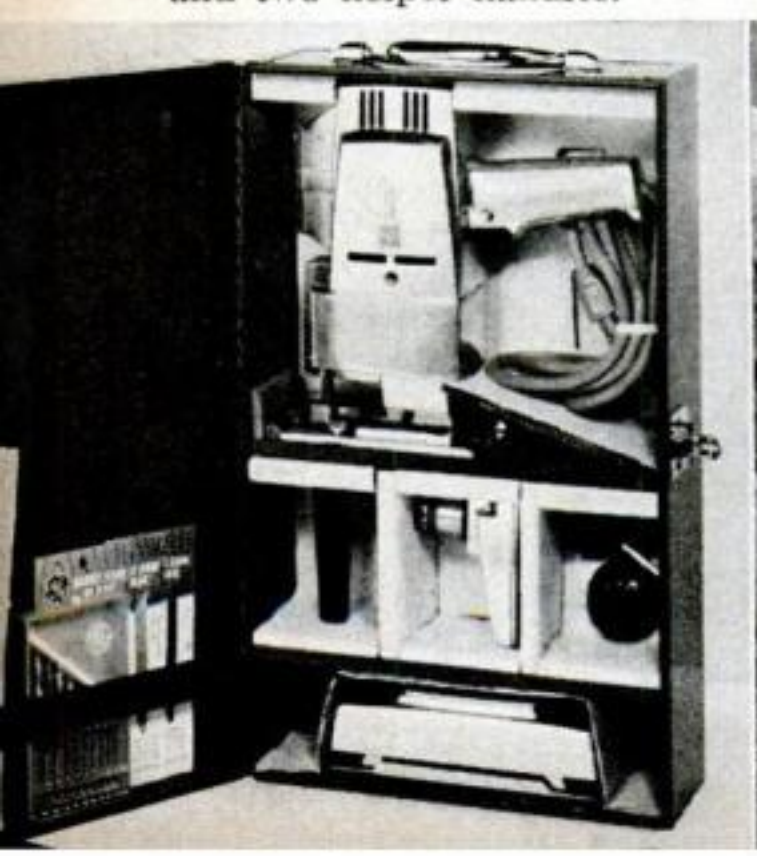
A deeply slotted fillister-head bolt would, I think, tighten more reliably than the round-head bolt used for clamping the shoe. In circle cutting with the rip guide as a radius bar, the cut consistently ran out 3/32″ in 90 degrees of swing. This may have been due to rotary play in the reciprocating shaft, or a misplaced pivot hole, in the pilot model that we tested for this article.

It sands smoothly. Somehow GE has tamed the 4,000 orbits per minutes of sander head to deliver less shake to the hand, but plenty of power to the work. Platen sands right up to a vertical surface in front or on either side.

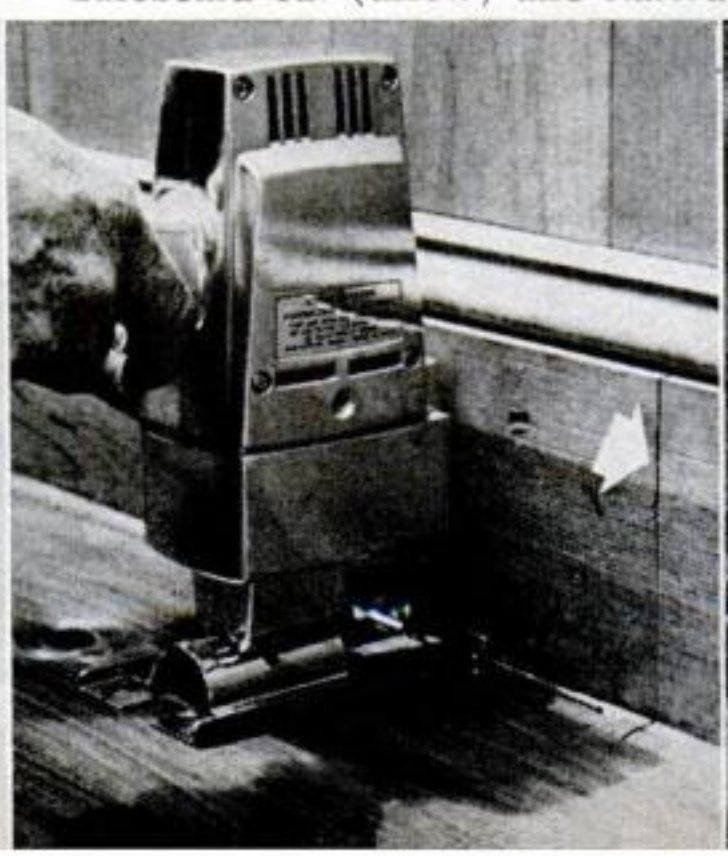
Pick any tool combination, but the best buy is the ¼″ drill, at $19; the motor costs you $2 less than with any other tool head. With the ⅜″ drill, it's priced at $24; with the sander or saber saw, $28. Bought separately, the ¼″ drill head is $7, the ⅜″ drill $10, sander or saber saw $14.

I would like to see electronic speed control added to the motor. It would give the drills and saber saw variable speeds at full power. With that, it would be hard to ask for anything more. ■■

Package deal includes a ⅜″ drill, sander, and saber saw in a steel case for $55. You get 10 high-speed twist drills, three saber blades, nine sheets of sandpaper, and two helper handles.



Retract the shoe of saber saw to rear position, and you can cut within ¼″ of a wall or baseboard. With the blade mounted at 90 degrees to the shoe, it can saw that close parallel to the vertical surface, as in photos below. Cut being made at left was started by gradually tilting the blade into floor board. A baseboard cut (arrow) also started with a plunge cut.



ADULT GAMES —no easy kid stuff

By Herbert Shuldiner

Photos by Robert D. Borst

"BERLIN army to Silesia," writes one of the conspirators in the smoke-filled map room. Another notes on a small map: "London Fleet to North Sea." Four other persons are seated around a table studying maps. They whisper and write orders affecting the fate of the world.

Who are these people? Diplomats? Generals? Heads of State?

Actually they're a bunch of suburbanites sitting in a game room, playing one of a new breed of adult games. These brain-busting recreational devices demand sharp strategy and intelligence, leaving little to pure chance.

The game these people are

CONTINUED

Strategy and skill count in today's new breed of parlor fun kits—designed to entertain everyone from lowbrows to eggheads

Urheberrechtlich geschütztes Material

Move over kids—adults are feeling more playful

playing, Diplomacy, is one of the toughest on the market. It allows three to seven people to try to outwit each other. The reward: "control" of 1914 Europe.

Diplomacy is published by Games Research Inc., a Boston outfit that turns out challenging diversions. Each move in Diplomacy, which uses a map of 1914 Europe as a playing field, is preceded by 15 minutes of whispered negotiations between the players. They try to gang up on each other, forming alliances and making war. But nothing is binding and the double cross is one of the best ways to win.

Trouble is that you might find it hard to explain to your wife after the game is over why you double-crossed her. Games Research president John Moot says women can't accept betrayal playing this game.

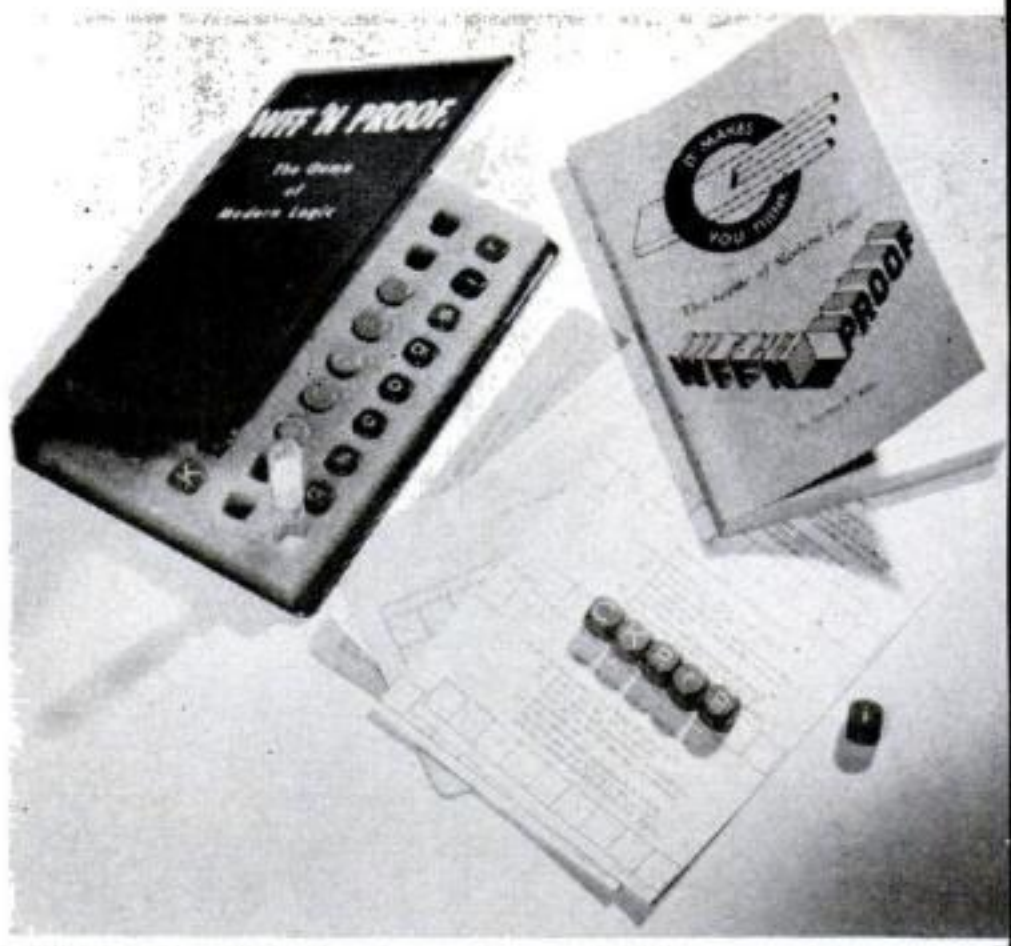
Why are adult games suddenly in? Increased leisure time seems to be making us more playful. Robert B. M. Barton, president of Parker Bros., one of the nation's leading game manufacturers, says his company's sales have hit over 12,000,000 games annually. James J. Shea, president of Milton Bradley Co. says his company is selling 35 percent more adult games now than it was just a few years ago.

People are playing these games mainly for fun, but they also want an intellectual challenge. Many adults got interested in games a few years ago when Scrabble became a national rage. Scrabble is still going strong, but there are quite a few competitors, especially games that utilize dice-like cubes, rather than tiles, to form words. Selchow & Righter Co., which makes Scrabble, also puts out a version in cubes. A similar game, Scribbage, is produced by the E. S. Low Co. These two games give you higher scores when you use certain letters that have higher point value. Parker's Spill and Spell cubes don't have individual point value. You get higher scores when you form longer words. Perquackey is a non-crossword version of this type of game.

Some word games like Bali, use cards that you have to arrange in solitaire fashion to form words like this:

C J M I E A N
O B
Y L
E

What's the longest word you can make of this hand? (Answer at end of article.)



Wff 'N Proof is the invention of Yale Law Professor Layman Allen. It's based on a propositional calculus system of logic and avid players are said to have raised their IQ scores more than 20 points. The kit costs $6.00 and contains 21 games that range from difficult to baffling.

Hidden cards make the Parker Probe a tricky game in which you have to guess what words your opponents have hidden. What's That on My Head? (see photo) makes you guess letters you wear in a crown on your head. You've got to use real logic to deduct the answers.

You can have fun by the numbers with Numble, in which you use tiles to form long numbers. The numbers must be divisible by three, and the longer the number, the higher your score. Strategy develops when you attempt to block your opponents from bonus boxes. Quinto is a new numbers game put on the market by the 3M Company. You play this game by placing up to five tiles on a board crossword-fashion. The numbers must total a multiple of five in all directions.

TV-inspired parlor games which give you an opportunity to form your own panel show rate high in the game market.

Milton Bradley's Alumni Fun is a board game in which you get a "college education" (move from start to finish of the playing board) by answering some tricky questions. Test yourself on these samples:

1. Eight is ⅛ of four times what number?
2. The first term of an arithmetic pro-

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and they are turning to brain-busting games for fun

Mille Bornes is a new card game from France. It has all the excitement of an auto race and the idea is to be the first player to travel 1,000 miles. You have to use strategy in deciding when to play a card that lets you go ahead, or when to stop your opponents.

Egghead's crowning dilemma results when he tries to guess What's That on My Head. Players of this game can see opponent's cards, but not their own. They try to guess the cards they wear by deduction, common sense, or less likely by making a lucky stab at it.

gression is 2 and the 5th term 14. The common difference is?

3. How far will a free falling body have traveled at the end of one second?

4. If the width and length of a square are each doubled, by what percent is the area increased?

5. If the angles of a triangle are in the ratio of 4.6:10, the triangle is?

(See answers at end of article.)

If you're in a fighting mood—there's a flood of absorbing war games to occupy your time. The war game started to come into vogue at about the time plans were being made to celebrate the Civil War Centennial. Several games were published then which allowed you to refight some of the famous battles that took place in the war between the states.

Now you can refight most of the major battles of World War II and many other historic encounters. Bradley's American Heritage series goes back to the War of 1812 with Broadside in which a Blue Navy (American) defends an attack by the Red Navy (British.) Battle Cry lets you fight from Bull Run to Shiloh. Dogfight is based on the aerial battles of World War I. Hit the Beach is a new addition to the series and brings you up to the Pacific campaigns of World War II. All the games are designed for use by two to four players on a maplike playing board. Handsomely illustrated booklets describing the historical highlights of the battles are an interesting educational aid in making the "battles" more realistic.

The Avalon Hill Co. has published another fine series of classic battle games. They're fun because you plot your own strategy, despite what happened historically. These games require sharp strategy and execution to whip your opponents. And the players take the games very seriously.

Avalon Hill publishes a magazine, called appropriately enough, The General, in which it reprints some of the better strategies game owners employ to win battles.

You can fight with or against the Afrika Korps or relive the last days of Stalingrad with the Avalon Games. You might even be Napoleon and refight the Battle of Waterloo. You could win this time. Even Walter Mitty never had it so good. ■ ■

Answers to questions

Bali letters form word enjoyable.

1. 12; 2. 3; 3. 16 feet; 4. 300 percent; 5. a right triangle.

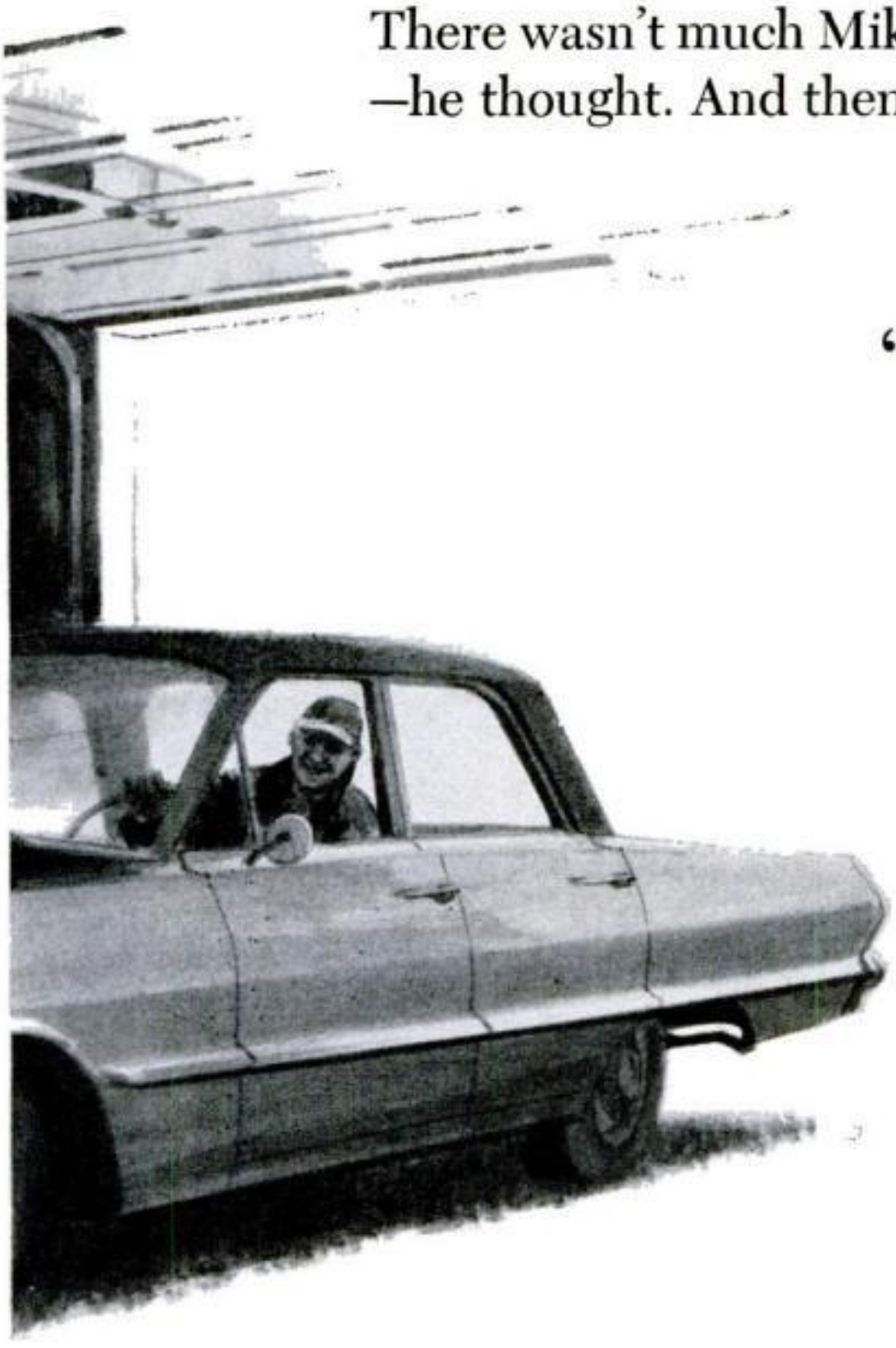
Urheberrechtlich geschütztes Material

Gus Rescues a Do-It-

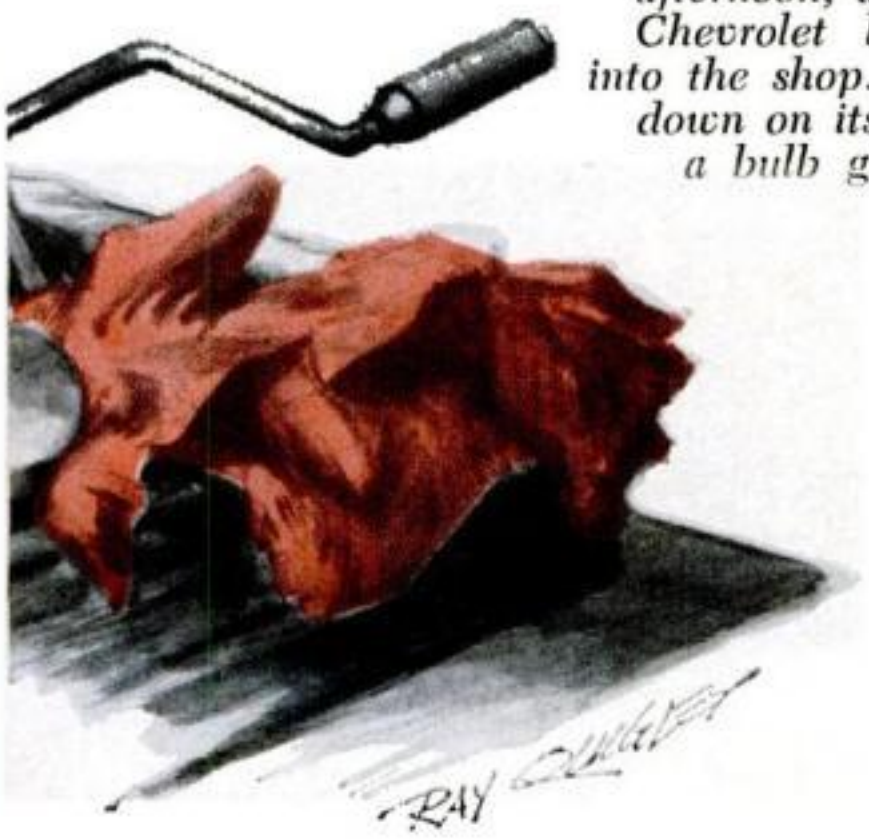
Urheberrechtlich geschütztes Materia

Yourself Mechanic

There wasn't much Mike Kessler didn't know about cars —he thought. And then he crossed wrenches with Gus



The following afternoon, a 1963 Chevrolet limped into the shop. Low down on its grille a bulb glowed.



By Martin Bunn

"LOOKS like Tweedledum and Tweedledee coming, Boss," announced Stan as he looked out of the Model Garage's front window.

"Strangers to me," said Gus Wilson. He opened the door, admitting two men who were remarkably alike—both middle-aged, rotund of face and figure, with pug noses and sandy eyebrows. They wore black windbreakers and hunting caps.

"I'm Mike Kessler," said one. "Got the electric fuel pump I ordered?"

"My name's Robbins," put in the other. "Grabbed a ride to bring you the trade-in on that rebuilt carb I phoned about."

"Oh, yes," said Gus, "I've got 'em both."

He took a carton from Robbins and lifted out a two-barrel Rochester carburetor, stained and worn, but otherwise identical to a gleaming rebuild on the workbench.

"There's the new one," said Gus. "It's guaranteed. Know how to make the adjustments?"

"My friend doesn't know much about cars," said Kessler. "I'll check it out."

Gus produced another carton. "Here's your fuel pump, Mr. Kessler. You'll probably want to reroute your fuel line and mount the pump on the firewall."

"I know that," snapped Kessler. "Already bought tubing and fittings."

"We're retired," added Robbins, "and like to do little jobs like this. Keeps us busy until hunting season. Six of us leave day after tomorrow in Mike's car and mine."

"Can't risk breakdowns in the back country," said Kessler. "My old Chrysler's in top shape except that the fuel-pump cam is worn. It doesn't move the pump full stroke, so I don't get enough gas at high speeds. Been getting vapor lock in hot spells, too. Going to an electric pump will kill two birds with one stone."

"Mike was a standards man on a Detroit

CONTINUED 177

Urheberrechtlich geschütztes Material

assembly line," explained Robbins. "Isn't much he doesn't know about cars."

Gus nodded amiably and handed both men their bills. They paid and left.

"What's a standards man, anyway?" asked Stan. "Some kind of inspector?"

"Some kind of," returned Gus with a chuckle. "He's a time-and-motion man who keeps assembly-line workers on their toes."

The following afternoon a '63 Chevrolet V-8 limped into the shop. Low down on its grille a bulb glowed brightly. Gus recognized it as a running light, favored by some drivers on the theory that it makes a car in motion more noticeable. The bulb winked out as the driver cut the engine.

"I put that carb on this morning," said Robbins, climbing out. "Been trying ever since to get the engine to run smooth. It idles rough and hasn't any pep."

Gus opened the hood. "Did your friend help you set the idle-speed adjustment?"

"No. He's la'd up with something. Hope he'll be in shape for our trip tomorrow."

Gus asked Robbins to start the engine again. It ran at a rocking, uneven idle. Making certain the automatic choke was open and the manifold valve in the "heat-off" position, Gus cautiously turned the two idle-mixture screws. The roughness persisted at every setting.

"Did it idle all right with the old carburetor?" he asked, cutting the engine.

"Yes. Ran okay too, except at high speeds. Then it sometimes missed. Didn't have pep for passing, or on hills. That's why Mike suggested a new carburetor."

Might be a fouled plug, or worn points, Gus mused, but the obvious thing to check first was the installation of the rebuilt carburetor. He got a ½" wrench and pulled on two of the mounting nuts, noting that the new gasket was in place. The nuts were tight. He tried a third, leaning lightly on the carburetor with his other hand.

Had it *moved?* Gus tugged at the carb. It did seem to give a trifle. When he pushed, it moved a fraction of an inch. Moving up the droplight, he peered at the nuts.

"I tightened those good," said Robbins.

"They are tight," agreed Gus. "But the carb's loose. How about the washers?"

"The ones that were under those nuts? One was split, and they weren't lock washers, so I figured they didn't really do much. I chucked them out."

Gus went to the stockroom, returning with four flat, copper-hued washers.

"You see," he explained as he unscrewed the nuts to place a washer under each, "these stud threads stop a little above the carburetor-mounting flange. When you tightened the nuts, you ran out of threads before they pinched down the flange. That left the carburetor loose enough to draw air in at the joint."

Gus retightened the nuts evenly, then started the engine. With slight adjustments of idling mixture and throttle stop screws, it idled smoothly. Robbins apologized profusely before he drove out.

"You shipped out Tweedledee," called Stan, "and Tweedledum's on the blower."

"Looks like that fuel pump you sold me is no good," said Kessler brusquely on the phone. "Better bring me a good one. I can't come for it—the car won't run."

"I don't often sell those," replied Gus, "so I checked that one myself. It works."

There was a long silence.

"You better come—but not in a tow truck," begged Kessler. "I don't want my wife to think I'm running up a big bill."

On the way—in his own car—it occurred to a mystified Gus that Kessler had made a quick recovery from being "laid up."

Inside the garage at Kessler's stood a big

CONTINUED

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COMET

LINCOLN-MERCURY DIVISION OF Ford

COMET CYCLONE HARDTOP WITH OPTIONAL TWIN SCOOP GT HOOD

For 1966: the big, new-generation Comets— our liveliest, roomiest driving machines ever.

This Comet looks the way it goes. Beautiful. And there are 11 Comets like it. Sleeker. Roomier. Up to 8 inches longer. Sedans, convertibles, wagons, hardtops... from rakish 202's to hot new Cyclone GT's. All with a very special kind of luxury.

Plus the features and options you want most. Bucket seats. Four-speed floor shift. Or three-speed automatic. Or three-speed manual with full synch. Vinyl roof. Built-in air conditioning. Power steering,

power brakes, power windows, power everything. Including a new 390 4-barrel V-8 in the new Cyclone GT. Look into it. Closely. At your Mercury dealer's.

Mercury COMET

the big, beautiful performance champion

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Chrysler. The owner emerged from behind the open hood, perspiring heavily.

"Now watch," he said. He got in the car and turned the key. The electric pump chuckled several times before the engine caught. "Now try to drive it off."

Gus got in, put the car in gear, and let out the clutch. The engine coughed. Gus eased the clutch back, revved up a bit more. With an enormous pop, the engine died.

"I've blown out the line, cleaned the filter, checked the ignition," said Kessler. "It has to be that pump!"

"Does sound like it isn't getting gas," said Gus, noting the gauge read "full."

"I've got to meet the fellows at six a.m. tomorrow," said Kessler desperately.

Under the hood, Gus saw that the fuel-pump opening in the block was neatly blanked off. The firewall where the pump was mounted had been scraped clean for a good ground. New tubing ran from the pump to the carburetor, and to the flexible hose coupling on the tank line.

Maybe an air leak on the suction side? Gus opened the joint at the pump, saw that the brass gland was in place, and retightened the nut. A wire was securely fastened to the pump terminal. Its other end was attached to one terminal of the ignition coil, which had a second wire on it as well. Gus disconnected the pump wire there.

"Got another pump in stock, or can you get one in a hurry?" asked Kessler.

"Won't have to," returned Gus. He ran the wire he had disconnected to the ignition resistor, fastening it to the terminal that received current from the switch.

"Now you try it," he told Kessler.

Again the pump chuckled before the engine fired up. Putting the transmission in gear, Kessler revved the engine. The car rolled halfway out of the garage as he let out the clutch. Hastily he drove back in.

"Well, it runs," he confessed grudgingly. "Why change the wiring? There's plenty of juice at the coil—enough for the whole ignition system."

"But not for the pump, too," said Gus. "In a 12-volt system, the coil gets full voltage only at starting. With the key at 'run,' a resistor gets into the act, cutting down voltage to save the points."

"But I hooked up a running light there once. You couldn't see any difference in its brightness," Kessler insisted.

"A fuel pump's more critical," explained Gus. "Getting juice through the resistor, at less than 12 volts, it was so starved for current it could only deliver enough gas for idling. Any time you opened the throttle, the engine simply ran out of gas.

"It's mighty tempting to connect accessories to that coil terminal, especially if you want them switched on automatically whenever the engine is running. But they won't get full power. Besides, there's an even more important reason not to use that coil post as a terminal board."

Kessler paid without demur.

"***Call me*** when Tweedledee shows up, Stan," said Gus, back at the Model Garage.

Robbins drove in an hour later. "That miss is still there," he complained.

Gus got out his plug-testing oscilloscope and hooked its four leads to the battery, the center distributor tower, and one spark-plug cable. With the engine running, he adjusted the instrument until an eight-spiked pattern steadied on the tube.

Then he pulled one cable off its plug and sped up the engine. The corresponding spike lengthened, but didn't reach the top.

"Spark voltage is low," said Gus, cutting the engine. "Be fixed in a jiffy."

He disconnected the extra wire he'd expected to find on the coil terminal and hooked it up to the ignition resistor's switch side. The lagging trace on the scope rose to the top of the tube face.

"You have full ignition voltage now," Gus remarked. "That should end your high-speed miss. It was only a bum connection."

"You fixed that car this morning," remarked Stan after Robbins left. "How come you expected friend Tweedledee back?"

"Something Tweedledum told me. He had connected his pal's running light through the ignition resistor, same as he did his own fuel pump, which didn't work. The bulb did, but it draws enough current to drop voltage to the coil about 15 percent. That reduced spark voltage—say, from 25,000 to 22,000 volts. At high speed or heavy load, when compression is up, the reduced voltage didn't fire reliably."

"Kessler thinks he's a car expert!"

"He went all out to keep Robbins from knowing about his pump trouble—told him he was sick, asked me to come in my own car. He just couldn't stand losing face."

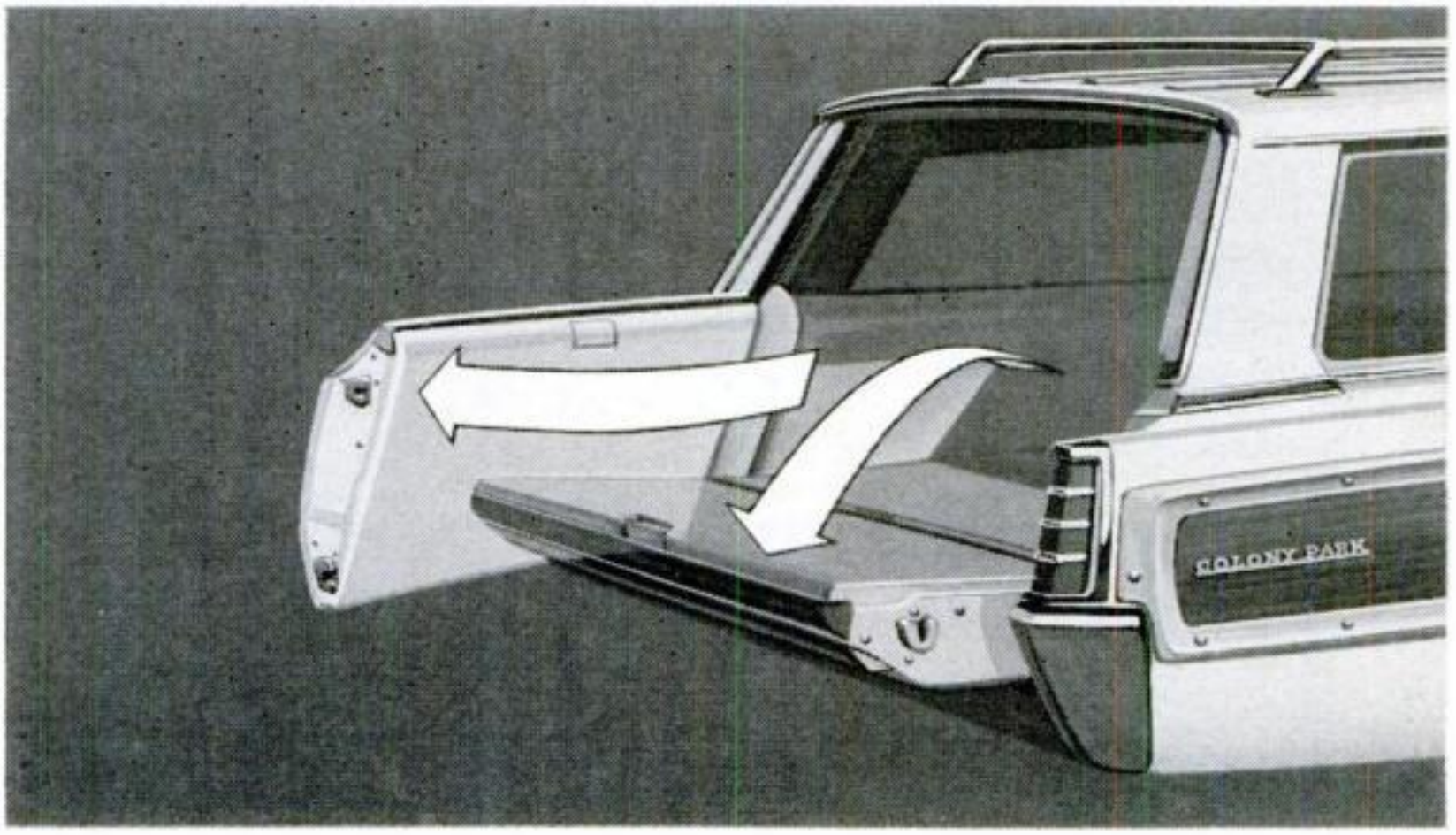
"I'd like to see his face," snorted Stan, "when his buddy tells him how he goofed."

"He won't," said Gus, grinning. "I never told him. Why spoil a hunting trip?" ■ ■

Urheberrecht ch geschützes Mate ial

New from Ford Motor Company

A station wagon tailgate that's a door that's a tailgate



Ford Motor Company, America's automotive innovator, has come up with the year's brightest idea for its '66 station wagons. It's a dual-action tailgate that lowers for loading or swings open like a door for extra-easy passenger access. Secret of the unique feature — available with all Falcon, Ford, Fairlane, Comet and Mercury wagons for '66 — is Ford-developed patented hinges. One hinge has twin pins for lateral or vertical pivoting action. Another is a door hinge that "unhinges" when tailgate is used in conventional manner. And a third hinge functions as both a hinge and a door latch! Whether you're loading lumber, parcels, or a carload of kids, Ford's exclusive door-and-tailgate doubles the pleasure of owning a wagon. See this great new feature, and the best wagons yet, at your Ford or Lincoln-Mercury dealer's now.

Ford

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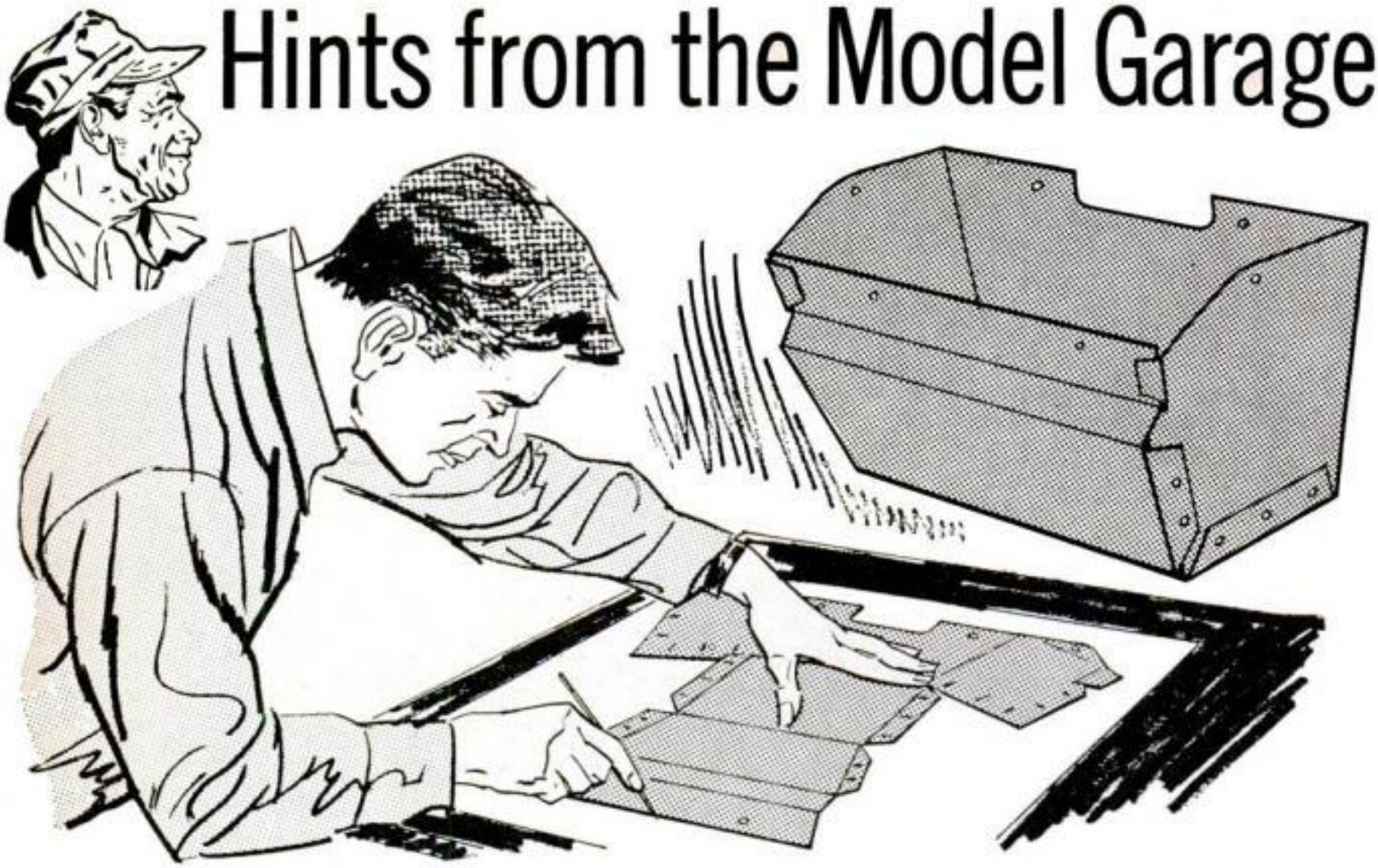
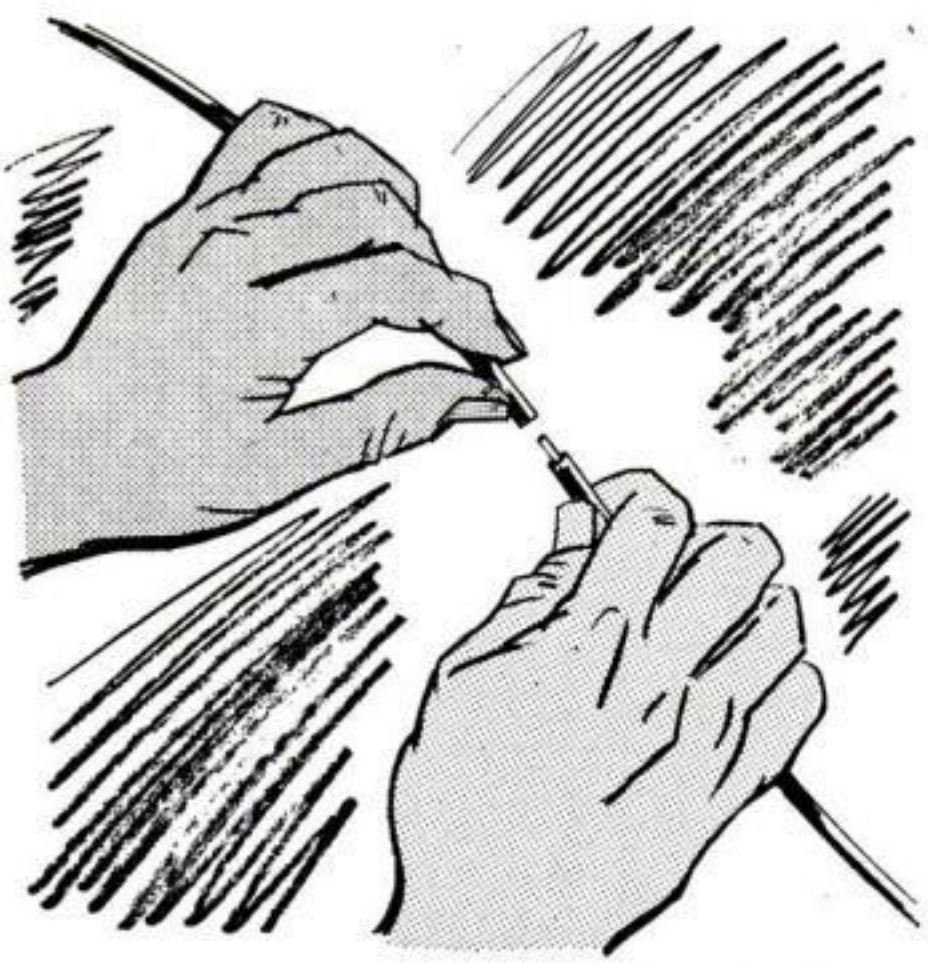
Hints from the Model Garage



Even if your glove box has a lock, it is not burglarproof, as the box itself is made of cardboard. A metal box can easily be fabricated by using the cardboard as a pattern. Remove the box, take out the staples, place the cardboard flat on a piece of light sheet metal, scribe the shape and mark the mounting holes. Next, cut the metal and drill the holes. Bend the metal into shape and fasten corners. Soldering should give sufficient strength. Bolt the new box in place, and lock it.

A loose insulation blanket under the hood can cause trouble. Fasten it with a thin rod across the front blanket edge, using a wire hook at each end. If the blanket is already damaged, protect the air-cleaner intake by adding a piece of screen wire.



A broken or cracked windshield washer line can be fixed by snipping off a piece of ball-point pen refill, inserting it into the broken line, joining the pieces and taping them. The refill is plastic, and a half-inch can be cut with no damage to the pen.

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22

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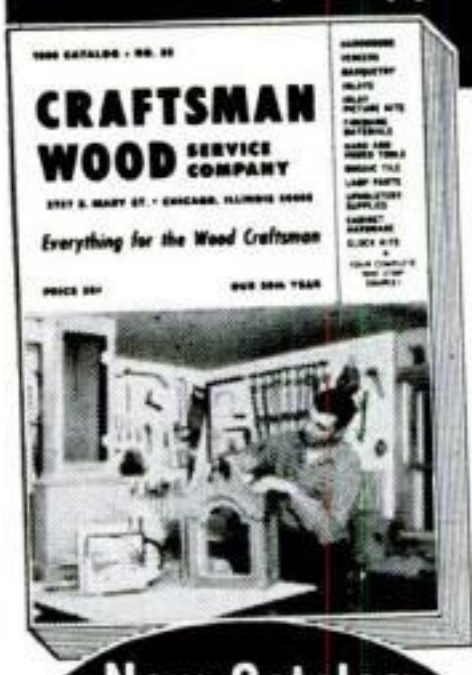

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[Continued from page 94]

with the optional rather than base-model six-cylinder engines. The Rambler engine is the most advanced, with sophisticated crankshaft counterweighting and seven main bearings, short stroke, and extremely short connecting rods, a lightweight cast-iron block, and fairly good porting. The Chevrolet is next in line, but the crankshaft has only four counterweights.

The Falcon Six began life with a four-bearing crankshaft, but Ford has updated the design by accommodating seven main bearings in the same basic block. A main bearing between each crank throw may extend engine life—but its main function is to keep the engine as free from noise, vibration, and harshness as possible.

The Valiant slant-six has only four bearings, but it has been developed to the point where it certainly has no noise and harshness problems. Neither does it seem to have more vibration than the Ford or the Chevy, though the Rambler is superior in this respect.

The obsolescent Valiant and the updated Falcon engines are coupled with the most satisfactory transmissions. Chrysler's junior edition of the TorqueFlite has been simplified (the rear oil pump is gone) but its operation is the same. Ford's lightweight Cruise-O-Matic, with three-speed planetary gearing, comes a close second to the TorqueFlite. Rambler's modern engine has a slightly antique transmission—they call it Flash-O-Matic, but it's really a Borg-Warner torque converter with three-speed planetary gearing. Still, it's better than the Chevy II's two-speed Powerglide.

Without an intermediate range, you get into unpleasant cycles of up-and-down-changing on hills, and you have a passing problem on the highway, where Low range is too slow and Drive lacks the power.

Comfort and convenience. I was not comfortably seated in either the Chevy II or the American—if I sat at the right distance from the pedals, the steering wheel was too close. The recliner mechanism on the Rambler seats works in notches and therefore misses any opportunity of a perfect adjustment. And the front seats just don't move back far enough for tall persons. The Falcon and the Valiant have enough front leg room but are short on leg room in the rear.

The windshield posts are a bit thick on all of them, but they all have good wipers. Only the Falcon has a foot-operated parking brake—the others have little dash-mounted umbrella handles.

You'll be interested in trunk size if you travel a lot with your own car, and more so with a compact than with a larger model. The Valiant trunk is by far the roomiest, since the spare wheel is cleverly hidden below the trunk floor. The Falcon has the smallest trunk (as hinted by the short deck), and the American and the Chevy II are about the same size, with spare wheels flat on the floor over on the right.

General notes. Plymouth Valiant begins its sixth model year with merely evolutionary changes in its "Phase-Two" look introduced on the 1963 models. Mechanical alterations include thicker brake linings, new universal joints and a new polyacrylic rear-axle pinion seal, all in the interest of improving durability. I would say that the Valiant is Outstanding Buy Number One.

Ford Falcon is an all-new car for its seventh model year, sharing many of its underbody parts with the larger Fairlane and consequently being the roomiest of the compacts. Naturally, it's slightly heavier than last year's model, but there is no significant loss of economy or performance. I give my vote to the Falcon as Outstanding Buy Number Two.

Rambler American had its big change for 1964 and in the third year of its second phase, it is very much the same as last year's car. Some small styling changes add to overall length without contributing to the useful space. The main mechanical news is a Motorola transistorized voltage regulator in a plastic capsule, with full protection against both moisture and shock.

Chevy II starts its fifth model year with a wholesale exchange of outer sheet metal, but the overall appearance is remarkably similar to the old Chevy II, and most dimensions are identical. This car represents an average of the compacts, and will probably be an acceptable compromise to thousands of nonenthusiast drivers. If the rear seat has above-average space, the front seating is below average. If the interior trim is below average, the exterior paint and brightware is above average. If it's better built than the Falcon, it still falls somewhat short of Rambler's quality of assembly. ■ ■

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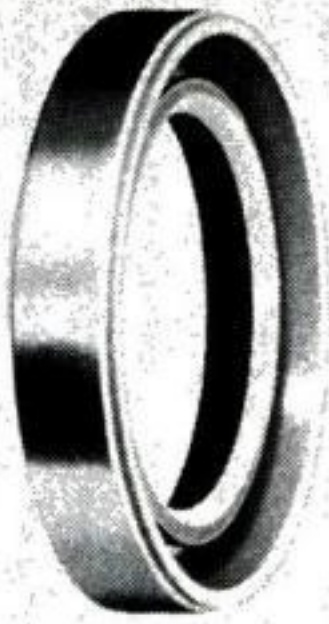
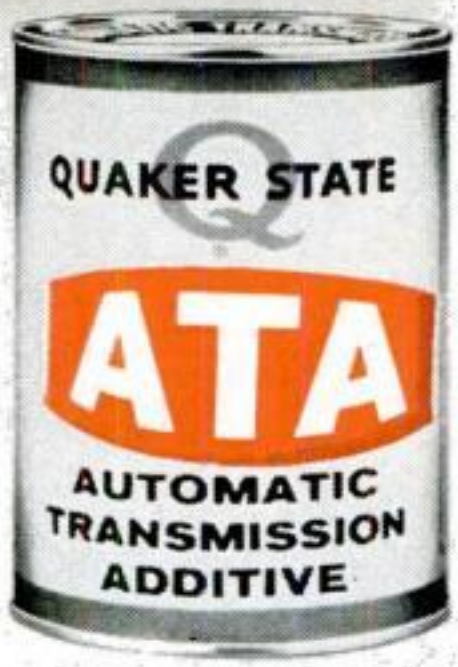
This is a transmission seal.





It can get hard and useless, and may cost $65 to replace.

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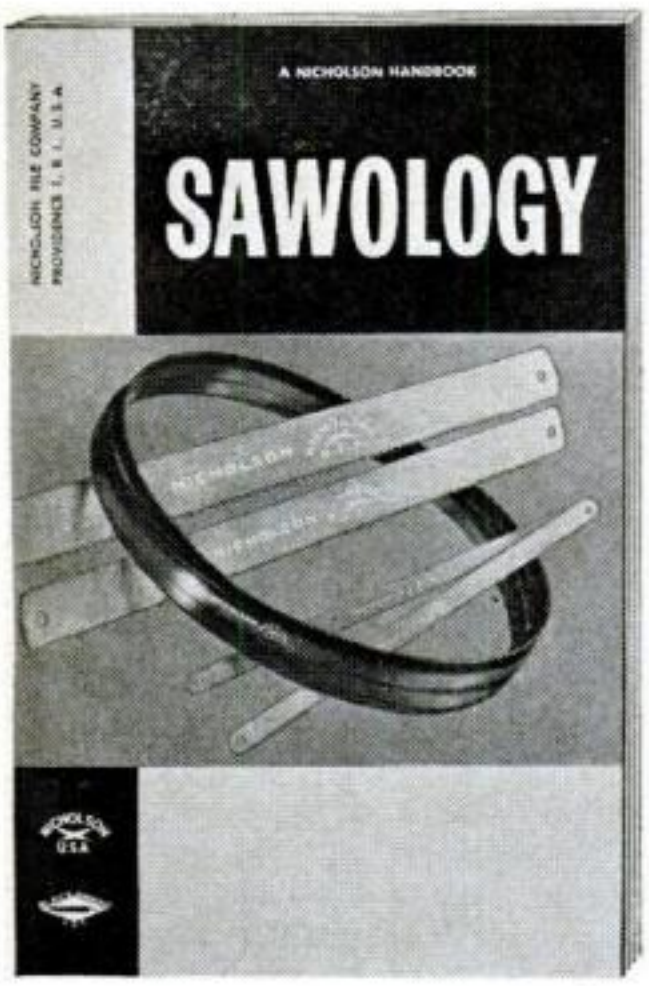

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Make Your Own Arc Welder

[Continued from page 145]

erator, wire a five-ohm, 150-watt power rheostat in series with the field windings. This variable resistance will control the generator's terminal voltage. With a smaller generator this rheostat can be omitted—you'll be able to control the generator's output sufficiently with the engine throttle. Wire a one- or two-ohm fixed resistance in series with the field windings if the generator heats excessively.

Stabilizing the arc. Because arc resistance fluctuates as you weld (globules of molten metal short-circuit the arc perhaps 20 times a second), heavy current is drawn from the generator in short spurts. These momentary high currents can cause the electrode to stick and the weld metal to spatter. A reactance coil—a three-layer coil of heavy magnet wire wound on a soft iron core—in the arc circuit will induce opposing current whenever current flow from the generator abruptly increases or decreases. The coil resists electrical change, thus stabilizing the arc.

Surplus houses sell ready-to-use reactance coils for about $10. If you want to wind your own, use No. 6 wire for a welder with up to 200-amp output.

Some aircraft generators—the 200-amp P-2, for example—have built-in cooling fans that make them excellent for continuous-duty welding. But most models don't, and a generator without a fan rapidly overheats if used continuously at full capacity. Mounting a 30-volt fan on the commutator end of the generator frame will improve the welder's cycle. Surplus firms have fans. Wire the fan in parallel with the load.

No. 4 copper welding cable, adequate for a small welder, costs about 25 cents a foot. You'll need two 10′ to 15′ lengths. When soldering terminal lugs on the cable, be sure to fill the lug sockets with solder. You'll also need a 200-amp-capacity electrode holder, a ground clamp, and a fiberglass helmet (cost for all, about $12).

How to arc-weld with DC. You can use either a flux-coated metal electrode or a copper-sheathed carbon electrode to strike the arc. If you're inexperienced, start with small-diameter contact electrodes—lengths of mild-steel wire heavily coated with a mixture of flux and powdered iron. Simply angle the electrode slightly in the direction of travel and drag it slowly along the joint to be welded. The electrode's coating main-

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f.o.b. factory Wt. 25 lbs.

Includes completely assembled cast iron and steel 8" tilt arbor power saw with ground cast iron table . . . less blade. If desired, RIP FENCE for easier work alignment, $3.50 additional

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Use as portable bench saw as received (inset photo) . . . or transform easily and inexpensively into floor model (as shown) guar. to do work of floor models costing $300. FREE plans . . . sheet of ¾" plywood and 3-4 hours are all you'll need. Use your AMCO saw for cutting. Plans provide 27" x 24" work surface, 33" height, pullout sawdust bin, tool storage compartment.

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PRECISION 4"x36" BELT SANDER $14.95

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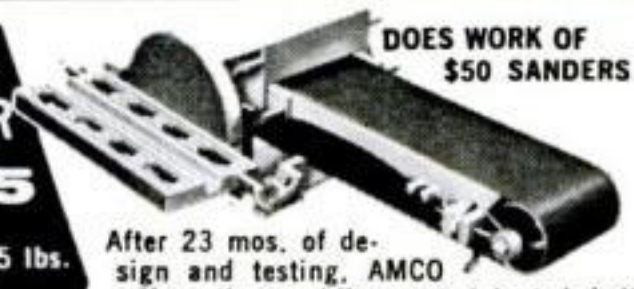
Optional Disc Sander incl. disc, bracket, ground cast table (tilts 0-45°): $7.95 add'l. Mitre gauge: $1.95 add'l.



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tains proper arc length. As the electrode burns, the coating forms a protective slag on the deposited weld metal. Knock off the slag when the weld cools.

Welding is simply a matter of fusing a small puddle of molten metal and working the puddle along a joint. Your first experiments on clean scrap metal will make it evident that the key problem is to achieve proper penetration—to melt a puddle deep enough to penetrate nearly to the bottom of the joint, but not melt through.

A larger arc has more heat and melts a bigger puddle than a smaller one. Increasing or decreasing the amperage from the generator regulates the arc's intensity. Accordingly, use low amperage with small-diameter electrodes when welding sheet metal. To weld heavier work, use higher amperage and larger-diameter electrodes. If the work you want to weld is so thick your welder can't melt a sufficiently deep puddle, grind the edges of the joint to bevels and fill up the V with repeated passes of the arc.

Changing the arc's polarity. This is another way to vary weld depth. Connecting the electrode to the welder's negative terminal—straight polarity—will give you a narrow, deep weld. Connect it to the positive terminal—reverse polarity—and you'll get a broad, shallow weld.

In carbon-arc welding—straight polarity is always used—separate welding rod is fed into the crater melted by the arc. The arc flame can be manipulated much as you'd use an oxyacetylene-torch flame. Its heat can be controlled by lengthening or shortening as well as by varying amperage.

You can also use the carbon arc for brazing. Clip off a length of brazing rod, lay it along the joint, and sprinkle on borax flux. Then play a long arc along the rod and work until the braze metal flows.

Although there's little danger from electrical shock when using a small DC welder, since the voltage is low, avoid welding in wet locations or when wearing wet gloves. Use your engine-generator welder in sheltered outdoor areas where there's plenty of ventilation to carry off engine exhaust. Wear protective clothing—the arc sunburns skin—and always protect your eyes with your welding helmet. *Never* weld on fuel tanks or other closed containers that have held volatile liquid. ■■

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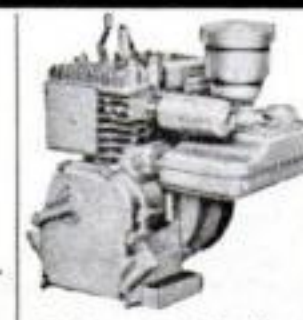
2 for $59.50
6 for ...$176.50



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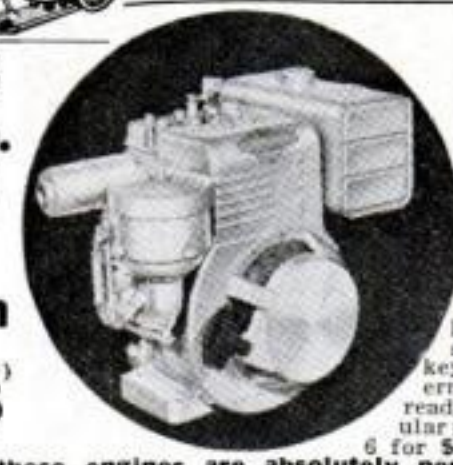
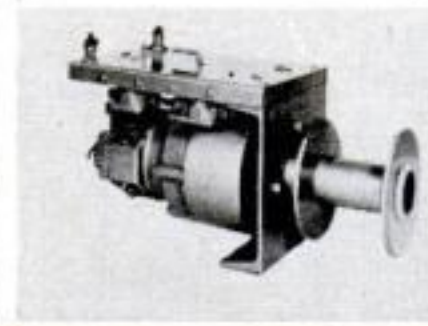


Briggs & Stratton 5¾ hp. Mdl. 143302. Recoil start. Std. 1" shaft w. keyway, and adjustable governor—a rugged big engine ready to tackle any job. Regular price $92.60. 2 for $135.00
6 for $375.00.

Remember these engines are absolutely perfect and standard and under factory warranty. Money back guarantee. Order now while stocks are complete. Factories—we buy new engines.



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A powerful, compact winch which installs easily even in limited space. Works with any 12, 24 or 32 volt system. Reverses under power—positive brake holds load. Drip proof cover. Remote control if desired. Drum holds 100 ft. of ¼" cable. Speed 30 ft. per minute. A terrific winch at an economy price.
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New transistorized model only

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Model 75

Free battery tester and adapter for special batteries included.
The EVERLITE 75—send $6.95 plus .65 for shipping.
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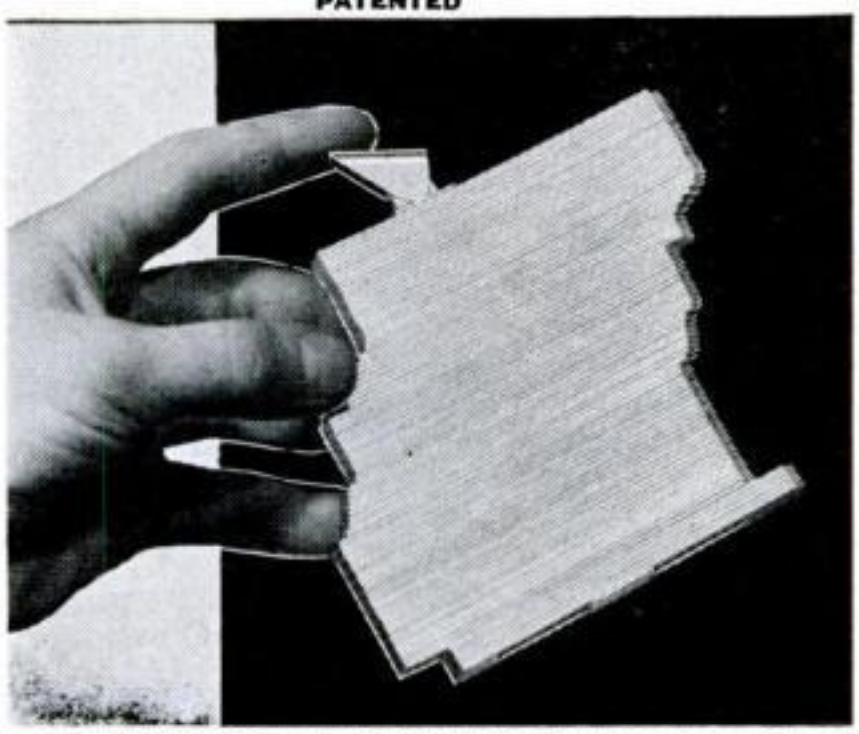

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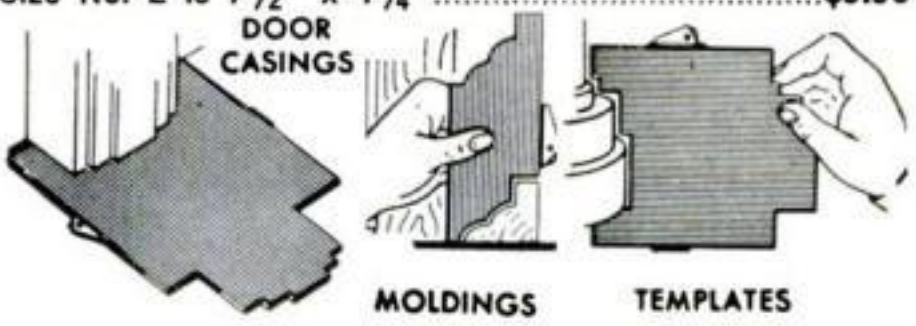

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work about a great
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the man next to you
must be smoking
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My Love Affair with Sand and Wheels

[*Continued from page 117*]

can't do. It takes a lot of nerve as well as skill to drop down some slope that seems all but perpendicular, to hit the bottom of a narrow canyon, and then work out a way on down, knowing that sooner or later a means of exit has to be found. Half a dozen different attempts may be made before an exit can be found that a good driver can negotiate.

The ideal course is one that the last car can cover in time to get back to camp an hour or two before dark. The better drivers get in an hour or two earlier.

The spice of hazard. Sometimes the explorers get into real trouble.

I remember one occasion when a string of explorers started working their way down the side of one of the high granite mountains and finally reached a point where they could go neither up nor down. There was a waterfall ahead that presented a sheer drop, and it was no longer possible to retrace their course.

Sam Hicks and I chartered an airplane from "Pinky" Brier and, with the president of the club, made an aerial survey. We worked out a way by which the cars could be winched, one at a time, up an almost perpendicular slope and then drive out under their own power.

The interesting thing, however, was what happened the first night the parties were stuck. They were on a mountain that rose over 5,000 feet above sea level. It was cold and dark. They sent out appeals over their Citizens Band radios, and the calls for help were picked up by various club members. All of them rallied to the call. Cars began arriving at the nearest accessible point with sleeping bags and provisions. The members of the stranded party had, of course, been forced to leave their cars and walk out, using precarious footholds, but eventually they rendezvoused with the rescue cars at the end of a fair four-wheel-drive road.

The stranded cars were in there for some two weeks before they were retrieved, and if it hadn't been for the aerial survey, might well be in there yet.

Man's inventive ingenuity always seems to find new forms of adventure. Just as snow skiing became an international sport, it seems that four-wheel-drive cars will furnish one of the most rapidly growing sports of today and bring thousands of sportsmen into the desert. ■ ■

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CLOSE-UP REPORT **Johnson Skee-Horse**

3 Models — 15½" and 20½" track, and 20½" track model with electric starting. New wide-track design for greater stability . . . "Snow-Claw" traction for greater go. New Torque Sensitive Drive gears itself to hill and load demands. New soft suspension cushions your ride. Positive disc brake. Exclusive lock-out neutral. Hi-lo beam headlight. Replaceable ski runners.

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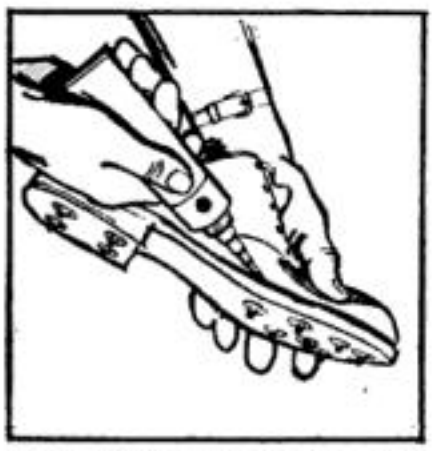
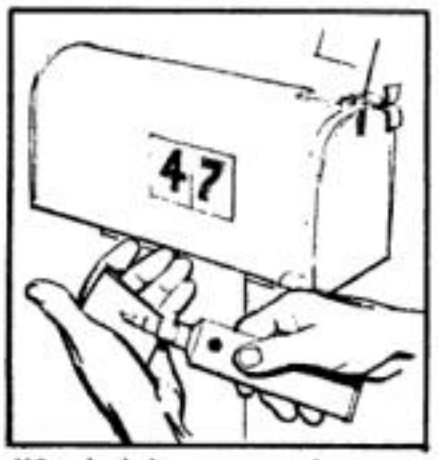
General Electric's amazing silicone rubber sealants, first used in space capsules, repair and mend hundreds of things around the house. Bond securely to most materials. Ideal for gluing and caulking jobs, indoors and outdoors. Permanently flexible and waterproof, they won't shrink, crack, harden or leak.

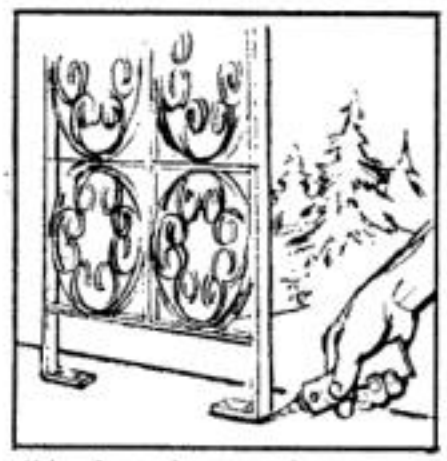


"Used Silicone Clear Seal to waterproof worn golf shoes at sole line. Worked beautifully. Stays flexible." L. L. Lannae, Washington, Georgia. (Clear Seal is transparent, makes invisible repairs on fabric, leather, rubber and other materials.)

"Resealed a door gasket for my clothes dryer with Silicone Bathtub Seal. No more leaks. Only adhesive that can stand the heat." William Jetter, Cincinnati, Ohio. (White Bathtub Seal also caulks bathtubs and tile. Won't shrink, dry out or harden.)



"Sealed house numbers to our rural mail box with Silicone Auto Seal. Now they'll never come off." William M. Smith, Dallas, Texas. (Black Auto Seal repairs convertible tops, cracked batteries and windshield gaskets.)



"Anchored a decorative metal column to our concrete porch floor with Silicone Metal Seal. Easier, faster and more economical than lag screws and anchors." L.M. LaBar, Bethlehem, Pa. (Metal Seal is also excellent for leaky rain gutters and storm windows.)

General Electric Silicone rubber sealants are available in 1 oz. and 3 oz. tubes for hundreds of large or small repair jobs. If you have used them for an unusual sealing job like those above, write and tell us. If we use your story in our advertising, we'll pay you $10. All ideas submitted become property of General Electric. Just write Sect. CT11162, Silicone Products Dept., General Electric Co., Waterford, N. Y.

GENERAL ELECTRIC

Come Visit the Village Inside a Mountain

[Continued from page 99]

itself, routed through special supplemental tunnels to the mountain's interior, would trigger the valves.

The great mass of the humpbacked mountain itself will protect the village from the dazzling heat of a nuclear explosion.

Nothing has been forgotten. The air supply, for example, is filtered continuously and sampled for purity against the contingency of cold-war sabotage. The water supply, pumped from Colorado Springs, also is sampled constantly. Floors are concrete—wood floors might splinter from shock. Where interoffice doors must have windows, they are made of shatterproof Plexiglas. In the event that enemy attack sealed off the village, remote-reading Geiger counters would keep it advised of the fallout density in the world outside.

Earth-moving machinery will be stored in the village so that its occupants can dig themselves out if attack should block the access tunnels. On the merest chance that any occupant of the village would at any time be exposed to a dose of radiation, special showers are provided for decontamination.

Buttoned up, the village after an attack would open the valves on its utilities by remote switches. It would have a vast store of uncontaminated water for domestic use and many million gallons in addition for cooling its diesels, running the air conditioners, and disposing of sewage. The filters in the ventilation system would guarantee a supply of air free of chemical, biological, or radiological impurities.

A bulldozer took its first bite off a flank of Cheyenne Mountain for NORAD village 4½ years ago. The site had been chosen from among a half-dozen proposed, all in the immediate area.

Only a dozen crow's-flight miles away lay the fabled, deserted mines of Cripple Creek and Poverty Gulch where men had dug and fought and died 70 years before to get at veins of gold worth millions.

"But we found no exotic metals in Cheyenne Mountain," commented Air Force Lt. Col. Chester M. Dellinger Jr., ruefully. A Californian, he is NORAD's project logistician.

When the last pound of 740 tons of dynamite had been touched off, and hard rock miners had hauled away 470,000 cubic yards of granite, the steel workers moved in

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to start building NORAD's hidden village.

The place is strictly functional. Its steel beams are visible. Over key doorways electric signs describe NORAD's alert status by "condition":

"5 4 3 2 1 ADE White ADW-Yellow Red"

The emergency mounts as you read left to right. "ADE" means Air Defense Emergency, "ADW" Air Defense Warning. "Red" means that bombers are overhead or, more likely, that thermonuclear-tipped missiles are about to fall.

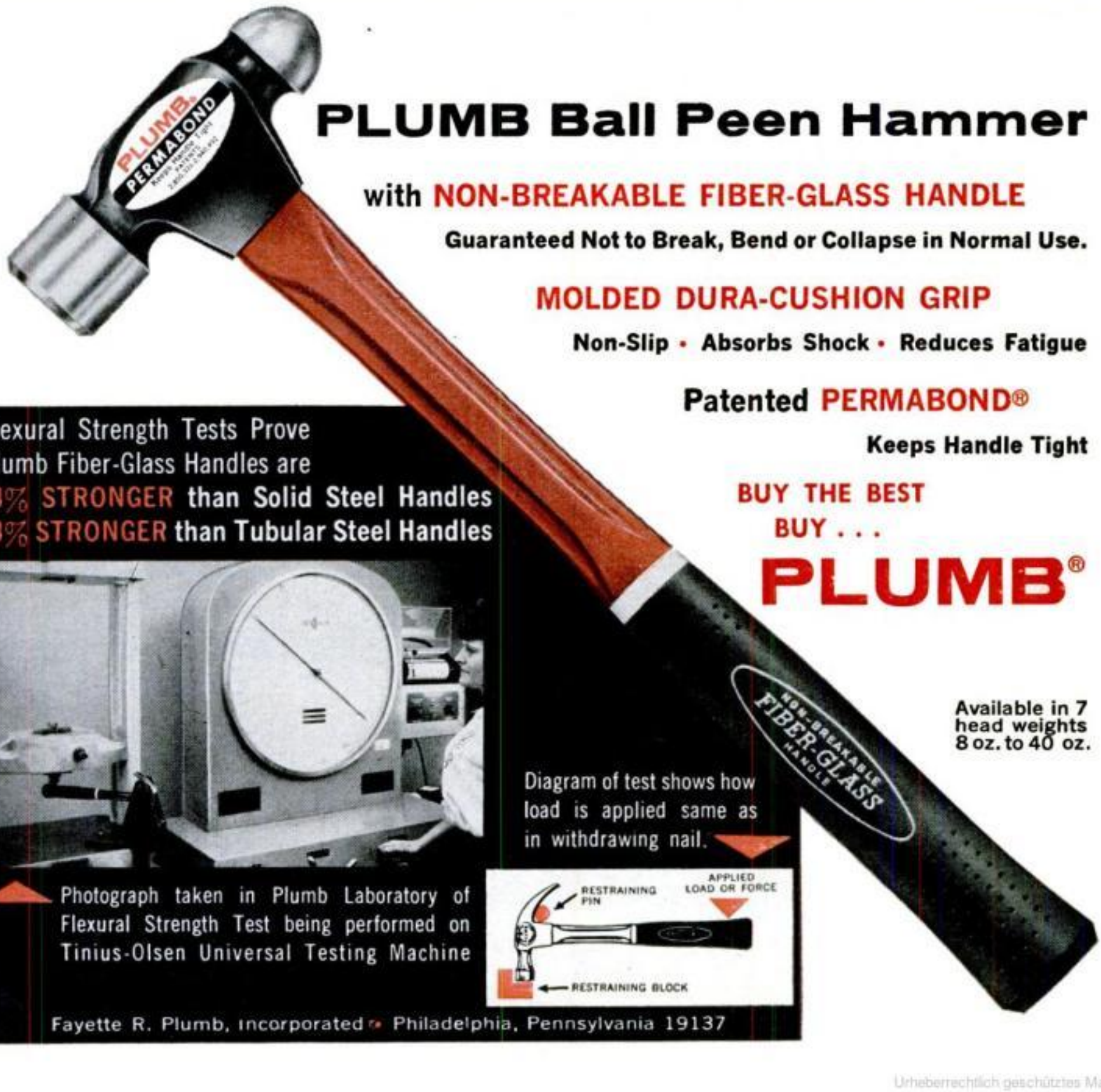
The village inside the mountain will command a world-wide radar network to detect enemy attacks in advance and launch retaliatory strikes from our jet-bomber bases, or missile sites, or missile-launching submarines, or all three.

No unidentified airplane can appear over the Bering Strait, no new artificial satelite can streak into space, without NORAD's knowledge. Computers accept, store, and regurgitate defense data at the press of a button.

NORAD village is not the continent's only underground defense installation. A SAGE (Semi-Automatic Ground Environment) warning network station—a part of NORAD—lies in a series of tunnels at North Bay, Ontario. There are others, too. They are secret. NORAD village is just the most elaborate, the most important.

The U.S. and Canada, in partnership in NORAD, not only admit the existence of NORAD village. They encourage publicity.

"First of all," explained an Air Force officer, "how could we hide the fact that we were tunneling out the mountain? Second, we consider our preparations for defense and retaliation a deterrent. We want potential enemies to know what they would be in for." ■■



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Photograph taken in Plumb Laboratory of Flexural Strength Test being performed on Tinius-Olsen Universal Testing Machine

Diagram of test shows how load is applied same as in withdrawing nail.

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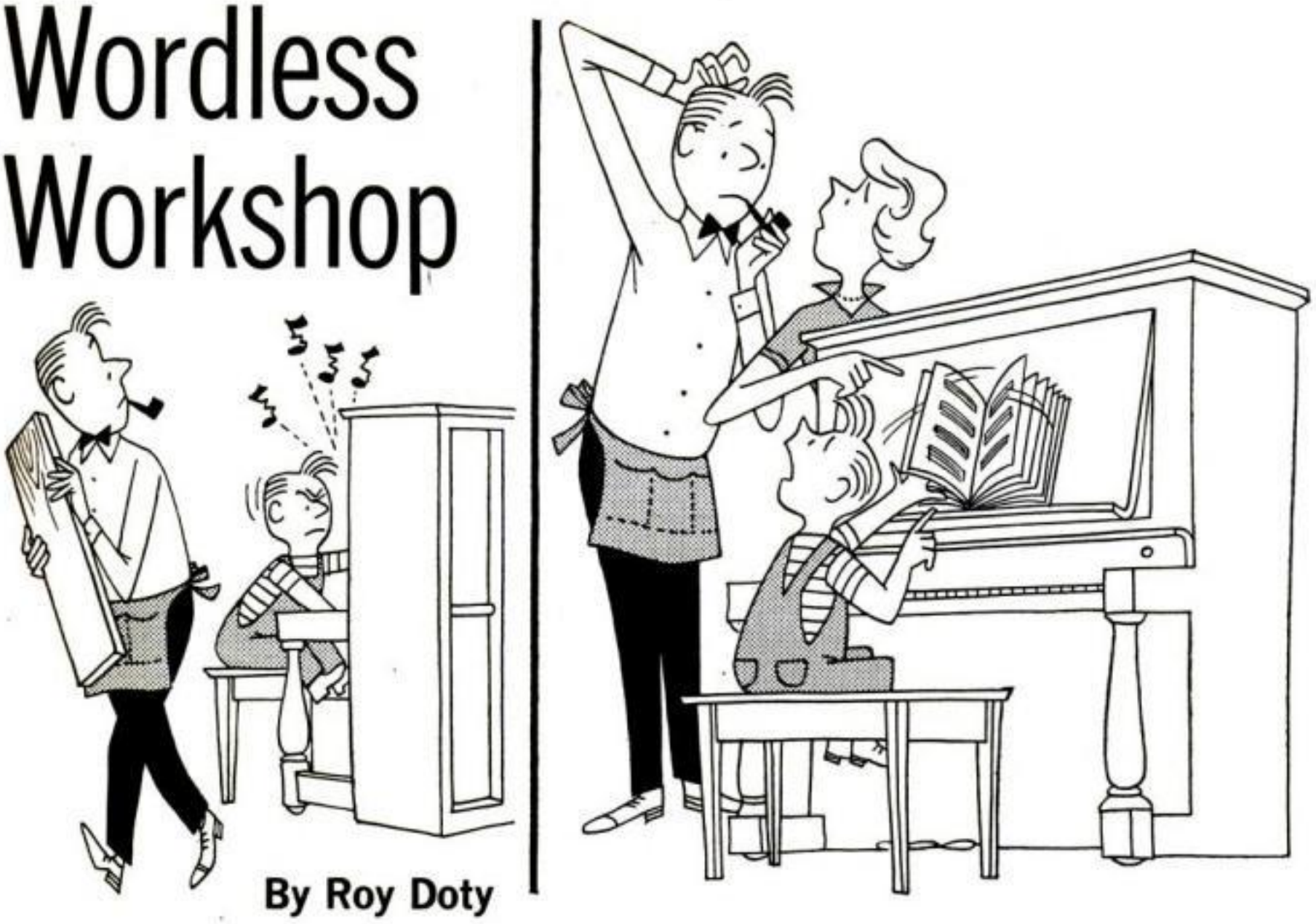
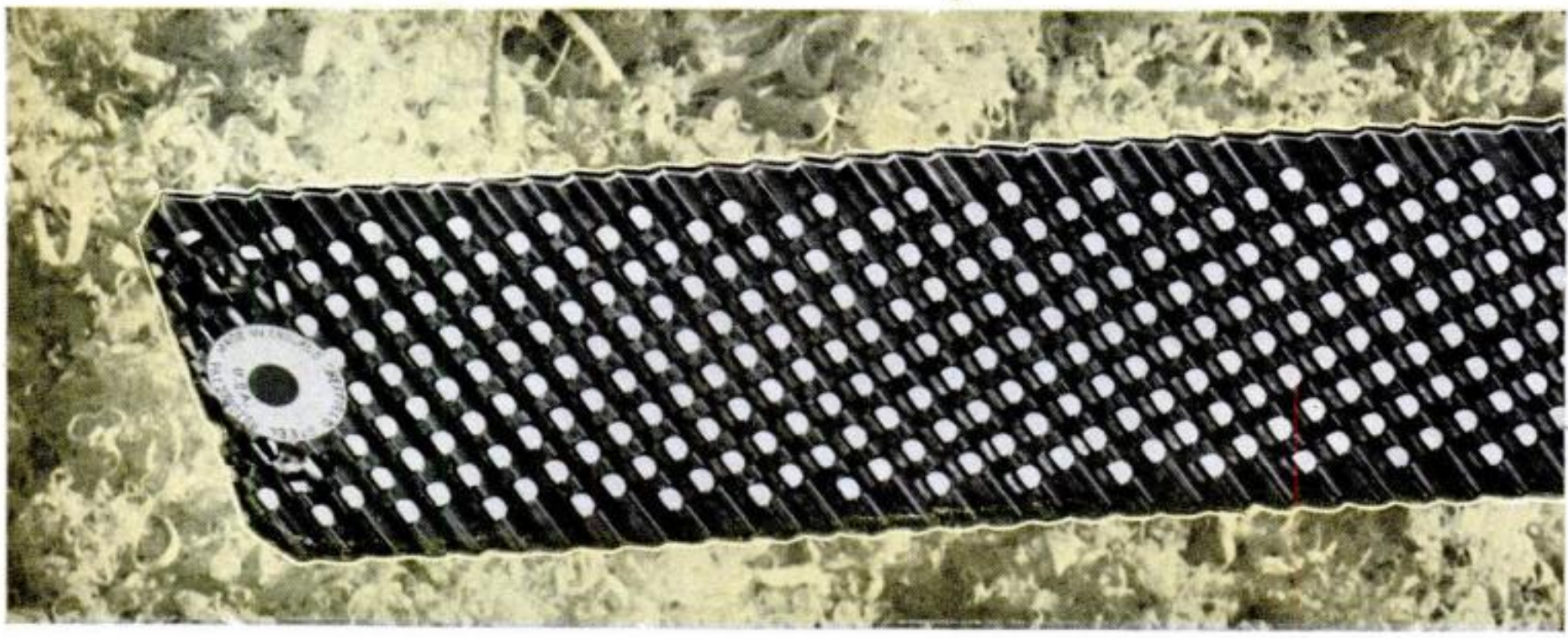
Wordless Workshop



By Roy Doty

Fast cutting, non-clogging . . .



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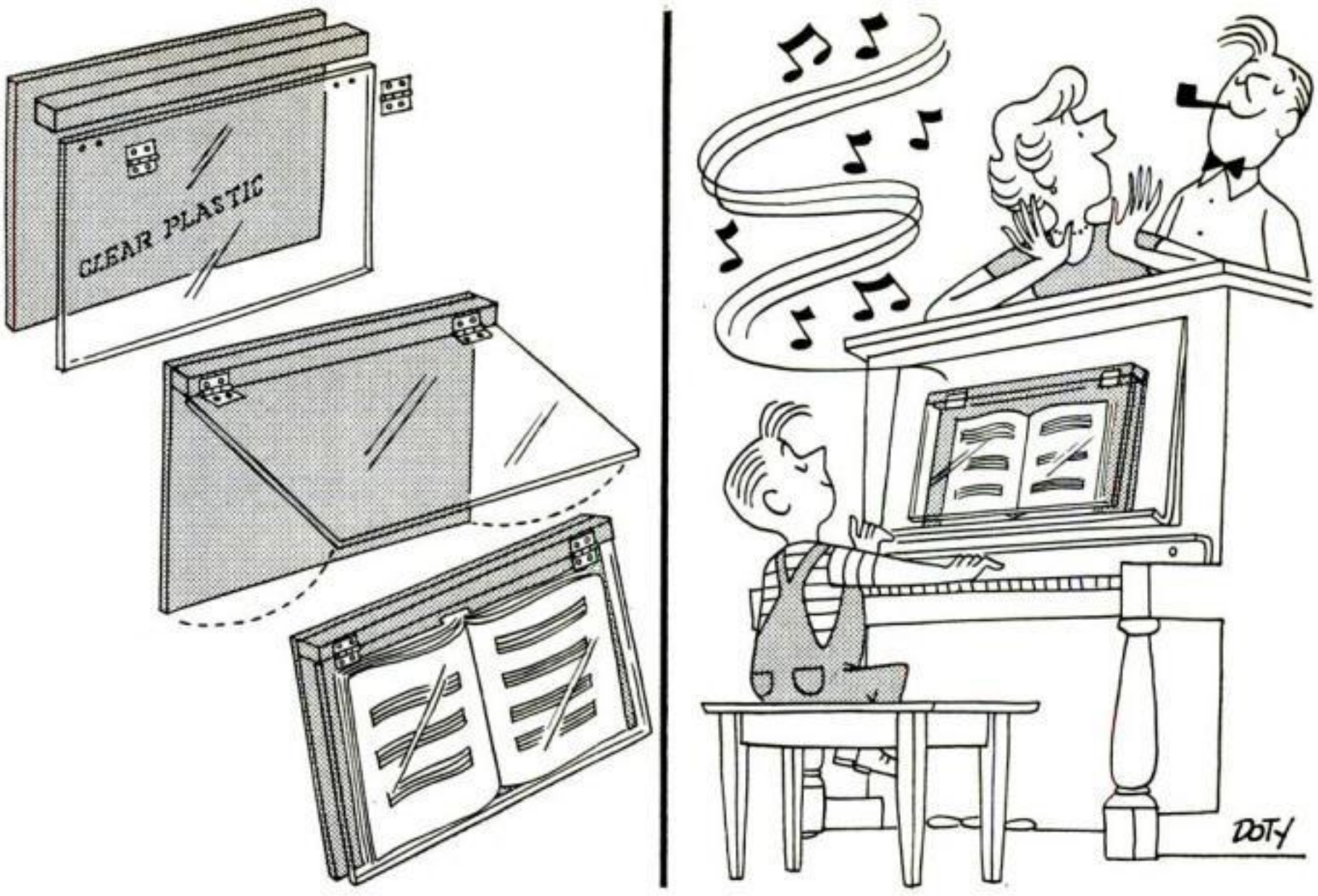
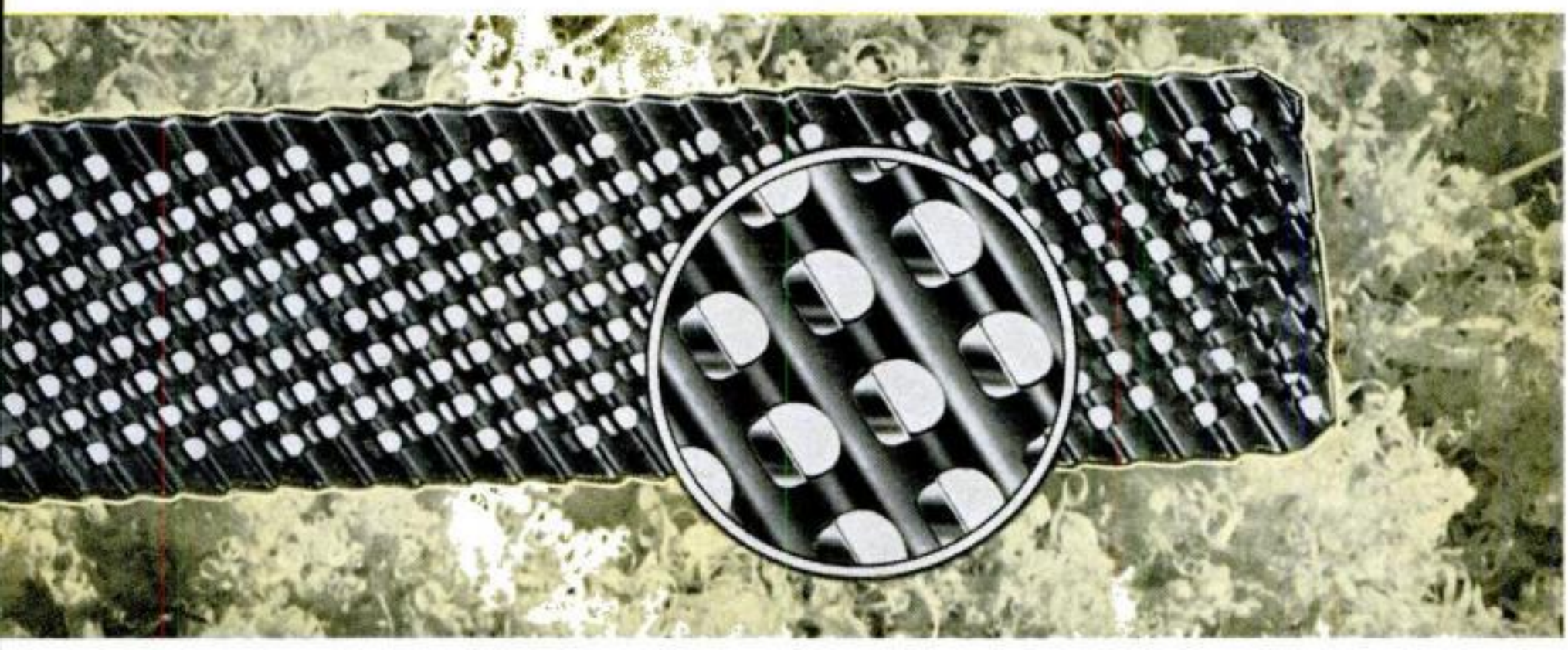
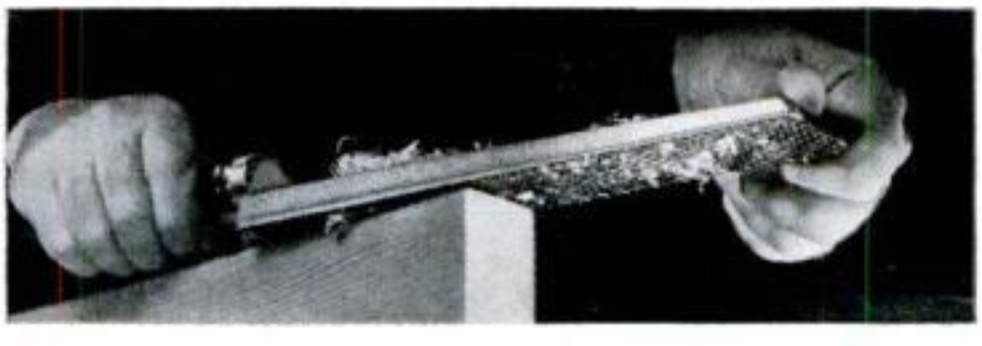


450 razor-sharp reasons why:





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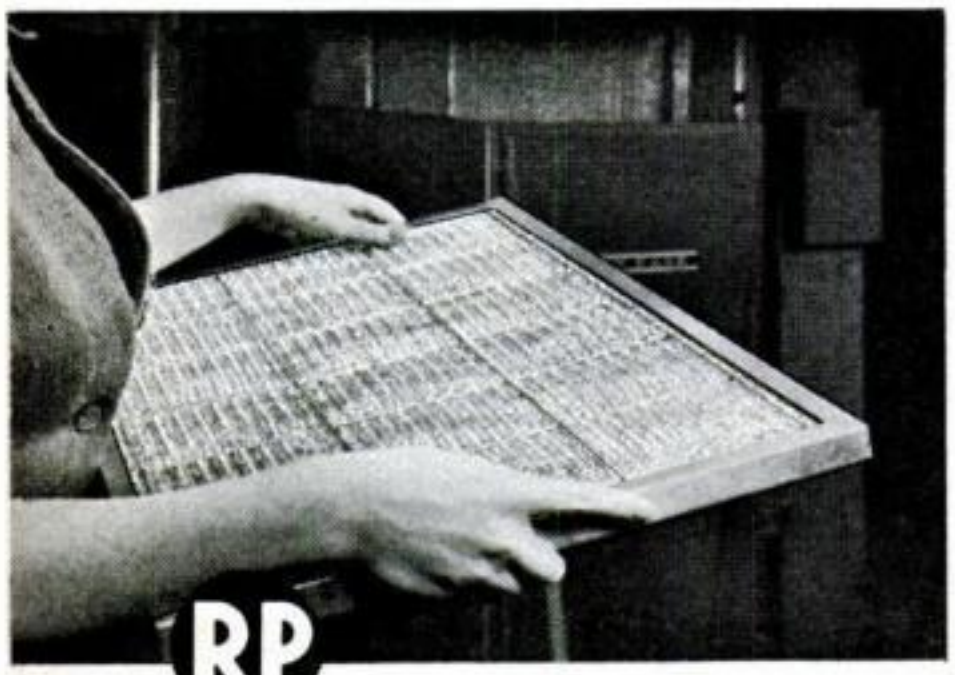
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How We Track Our Spacecraft

[Continued from page 109]

like that of an Askania cine-theodolite, but much larger. It can produce high-resolution pictures of far-away events such as separation of the first rocket stage, and ignition of the second.

The downrange stations. Before we come to electronic tracking equipment, let us take a quick look at the Eastern Test Range's 11 downrange stations. Remember, Cape Kennedy proper is Range Station No. 1. About 100 miles to the south, still on the Florida mainland, is Station No. 2 at Jupiter Inlet. Stations 3 through 9 are respectively at Grand Bahama Island, Eleuthera Island, San Salvador, Mayaguana, Grand Turk, the Dominican Republic, and Puerto Rico. Station No. 10, at St. Lucia, has become inactive. Station No. 11 is on Fernando de Noronha, a Brazilian island. And the last of the dozen is on lonely Ascension Island, a British island eight degrees south of the equator and more than 5,000 miles from Cape Kennedy.

Electronic tracking systems. The Eastern Test Range's systems of this kind can be roughly divided into "pulse radar" and "continuous wave" equipment.

Radar tracking is done by aiming a rapid fire of powerful radio pulses at the speeding rocket. The signals are reflected either by the rocket's metal skin ("skin tracking"), or by an amplifier beacon carried in the rocket ("beacon tracking"). The same antenna dish that bundles the outgoing pulse, and aims it at the rocket, collects the returning electronic "echo" and sends it to a receiver. The slant distance from radar unit to space vehicle is shown by the elapsed time between a pulse's departure and return; the line of sight to the bird by the direction from which the loudest echo comes. The Eastern Test Range has a vast array of radar sets, ranging from venerable AN-FPS-16 units to the still-experimental AN-FPS-43. Not all of ETR's radars are used for tracking rockets, however; some (such as AN-FPS-8 units) keep the skies under surveillance for intruding aircraft, or aid the tracking radars in target acquisition.

Using the Doppler effect. Continuous-wave tracking systems are based on the Doppler effect—the familiar phenomenon of a train whistle's drop in pitch as the locomotive passes. A continuous signal of well-stabilized frequency is sent up to the rocket. The speeding rocket receives the electromag-

CONTINUED

winter... it's wonderful!

Evinrude's new SKEETER is here. Forecast: **Action!** And winter will seem to be about half as long as it used to.

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Choose from three models for 1966, including two new Wide-Track SKEETERS. All have new, automatic, **torque-sensing drive** for peak performance under any condition of load or terrain. Special winter-engineered 14 hp engine gives speeds to over 30 mph.

Let it snow! You can't go SKEETERING without it.

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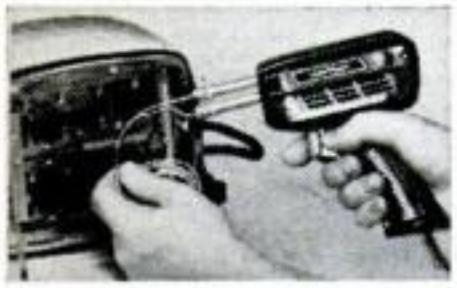

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Kit includes: Weller 100/140 watt dual heat gun, 3 soldering tips, tip-changing wrench, flux brush, soldering aid, solder, break-proof plastic case. Model 8200PK. **$8.95** list

WELLER ELECTRIC CORP., Easton, Pa.

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netic waves at a somewhat lower frequency, just like a ship running with the waves. As the received signal is radioed back to the ground station, an additional Doppler shift in the frequency occurs.

By comparing the outgoing frequency and the returning one, the ground station can thus determine precisely at what rate of speed the rocket is receding from the station, along the line of sight. By taking this measurement from several locations on the ground, simultaneously, the rocket's flight path can be determined.

Instead of several independent ground stations, however, all continuous-wave tracking systems are using one central transmitter-receiver-evaluator complex, connected to an array of rather widely dispersed antennas that are laid on the ground in a suitable geometric pattern. The system then utilizes the small differences between transmitted and received signals, as noted at the various antenna locations, to learn the space vehicle's flight path.

The Eastern Test Range has the following types of CW tracking systems: Azusa, Mistram, Udop, and Glotrac. All use the Doppler effect; their differences lie in how they utilize the effect for highest accuracy in flight-path determination.

Ships help, too. Orbital flights launched from Cape Kennedy invariably pass over wide stretches of ocean. To assure uninterrupted tracking for critical flight phases—such as powered ascent, or power maneuvers in orbit—the Eastern Test Range operates several tracking ships. Like the land-based stations of the Range, these vessels are equipped with just about everything that can nail down the exact flight path of a space vehicle.

Range ships thus become a vital factor in making space operations effective and safe. In addition to radars and computers, the ships are equipped with an inertial-guidance system similar to those used in nuclear submarines. This unit not only determines the exact location of the ship, regardless of visibility of landmarks or stars, but it also gives a reference for all radar antennas aboard, and furnishes an input on pitch, yaw, and roll motions of the ship during tracking operations. During data reduction, the ship's motions are subtracted from the antenna pointings—with the result that data are, for all practical purposes, received by an antenna on a stable platform.

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Pros and Cons of Jet Power for Small Boats

[Continued from page 89]

drive right through the middle of a water flower garden.

You usually can get away with it, particularly if you maintain a high rate of speed so the jet unit can grind up all the vegetables it inhales. But if you pause just a little, you're apt to pause quite a lot—with a pump full of cole slaw. Another booby trap: You don't try to run right up to the beach and over the rocks with a propeller-driven boat. But once you're convinced your jet will sail across country on a heavy autumn dew you're quite apt to go places that will actually damage the hull.

There are three principal types of jet-propulsion units for small boats. One is an inboard pump unit, one an inboard engine with a modified inboard/outboard style of jet, and the third a jet-pump unit designed to replace the lower propeller unit on an outboard motor.

Users of outboard jets report that they obtain 85 to 90 percent of stock propeller speeds when pitched to carry a useful load in the boat. Under heavier loading conditions, this ratio may drop to about 80 percent, depending upon the hull being used.

On inboard pleasure boats, the most popular applications of jet drives are for water skiing, wake surfing, cruising, fishing, river running, and skin diving. These are usually inboard planing hulls between 14 and 23 feet long. The engine may be almost any inboard producing between 100 and 300 hp. A typical boat might be about 18 feet long with a seven-foot beam. It would be equipped with a 327-cu.-in. V-8 engine and might have a top speed of 50 m.p.h.

Up to 80.8 m.p.h. Another popular application of jet power is in the California-style Ski-Drag boats. Speeds in these have been clocked up to 80.8 m.p.h.

One unique and lively use of outboard jets is on surfboats along the Oregon coast. The boats are rolled down the sandy beach on inflatable rollers, right down to the surf line. Once off the rubber rollers, the boat rests on the sand until an incoming wave lifts it momentarily. Then the engine is started and away you go, out through the surf for salmon fishing beyond the breakers. The trip back is even more spectacular, as the boats come in like surfboards, under full power, racing ahead of the breakers and sliding up high and dry on the beach. ■ ■

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[Continued from page 105]

Mount Palomar, instead of seeing a calculated one billion light-years, could now probably see two billion—almost enough to settle the question of the origin of the universe. There was another important result: The time back to the big bang was recalculated to be more than five billion years. One big objection to the theory—the earth being older than the universe—was out.

By 1956, the Palomar instrument had been used to measure the red shifts of 18 galaxies near the telescope's limit. Though the measurements weren't conclusive, they showed an astonishing thing: The stars at the very outer limit of the telescope's range seemed to show a red shift slightly greater than would be strictly proportional to distance. If the measurements were confirmed, the big bang would get a powerful boost.

In 1958, the big telescope produced another shocker. Dr. Allan R. Sandage, a prominent young astronomer, found that the distance-measuring yardstick that had been doubled in 1953 was still too small. Once more, the universe was older and bigger.

Noises from space. Meanwhile another major development was on the way. Radio astronomers, listening to the faint crackling noises that come from many spots in the heavens, found that there were certain mysterious radio sources not definitely identifiable with any visible celestial object.

The positions of some of these odd celestial transmitters were sent to Palomar, where two astronomers, Drs. Jesse L. Greenstein and Maarten Schmidt, used the big eye to investigate them. In each case, they found small, ordinary-looking stars that, like millions of others, had been noted but never studied. They were assumed to be minor stars on the fringes of our galaxy. When the scientists tried to get red shifts on the stars, though, nothing worked. The lines wouldn't fit into any known pattern. For two years, the strange radio sources remained a mystery.

Then came a discovery that was to rock the entire field of cosmology. It suddenly occurred to Schmidt that perhaps the objects were not in our galaxy at all, but far, far outside. He examined the lines again, and finally found absorption lines of hydrogen and oxygen, red shifted almost beyond recognition. One of the objects thus identified, a weird celestial body called 3C-48, was moving away from earth at the aston-

CONTINUED

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ishing rate of one-third the speed of light. It was more than 3.6 billion light-years from the earth.

The quasars. This 3C-48 and its odd companions were clearly the most remarkable things ever discovered in the skies. They appeared faint only because they were extremely distant. In fact, Schmidt and Greenstein calculated, they are the brightest objects in the universe; some of them shine with a brilliance exceeding 100 galaxies of 100 billion stars each. And they throw out radio energy in similar lavish amounts. Said Greenstein: "They're perhaps the most bizarre and puzzling objects ever observed through a telescope." Since nobody knew what the brilliant objects were, they were called "quasi-stellar sources," or, for short, quasars.

Quasars immediately opened up new possibilities for settling the question of the origin of the universe. It had been thought that the maximum range of the Palomar telescope was something over two billion light-years. These unbelievably bright quasars, though, could be seen at many times that distance. Perhaps now we could see six, eight, 10 billion light-years—almost back to the beginning of the universe. Schmidt, Greenstein, and their colleagues began trying to isolate other quasars and measure their red shifts.

It was slow, tedious work. Nightly, the scientists crawled up the framework of the giant telescope and mounted tiny films in a small camera at the instrument's focal point high above the floor. So weak was the light filtering in from the strange objects that it took hours of precious telescope time to register a few fuzzy spectral lines on the film. But it paid off. In December, 1963, 3C-286 was discovered speeding away from earth at 55 percent of the speed of light. By this May, 40 quasars had been identified. One of them, 3C-9, was whizzing away from our part of the universe at 80 percent of the speed of light, making it easily the oldest and most distant object ever sighted. "The light we now see from 3C-9 left it many billions of years ago, before the sun and earth were born and when the expanding universe was only a third as large as it is now," said Dr. Schmidt.

Astronomers were just beginning to collect enough quasars to be useful when a new rash of discoveries turned up a series

CONTINUED

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They're Solving the World's Greatest Mystery of powerful clues. The first came from radio astronomer Arno Penzias and his associates.

The noisy horn. Several years ago, Bell Laboratories built a large antenna shaped something like a cow's horn for use with communications satellites. Engineers using it noticed something strange: The antenna was noisier than they had anticipated.

This spring, Penzias used the antenna to measure the strength of some celestial radio sources and ran head-on into the noise nobody could explain. "There were a number of joints near the small end of the antenna," said Penzias, "so we took them apart, cleaned them, and put the whole thing back together. It turned out that none of them were giving any trouble. Then we got a special aluminum tape and taped the joints in the rest of the horn. And we scrubbed the thing. Nothing helped."

One day last May, Penzias told a scientist friend about his trouble. "You'd better see Dicke," said the friend.

Dr. Robert H. Dicke of Princeton, a prominent physicist and cosmologist, and several of his colleagues had just worked out a startling theory. If there had been a monstrous bang in the past, they theorized, there should have been a cataclysmic light flash of unbelievable magnitude. And somewhere the energy that began radiating from that flash would still be around. Of course, it would be shifted far down into the radio region now by the Doppler effect. According to calculations, it should show up as very faint radio noise. Dicke and his team were building a radio telescope to listen for the noise when Penzias called.

Theory and noise. Dicke, it turned out, had a theory and nothing to support it. Penzias had noise but no theory. They put the two together and got a perfect fit. The rustle in Penzias' antenna is the faint whimper of the bang that began the universe.

Less than a week after Penzias and Dicke got together, Allan Sandage of Palomar announced another landmark discovery. He had been seeking a better method of screening the sky for quasars and had come up with an ingenious plan. He knew that quasars radiated proportionally more light in the ultraviolet range than most stars. So he turned a telescope on a patch of sky and took a picture through a blue filter. Then he moved the telescope slightly, put on an ultraviolet filter, and exposed the same piece of film again.

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They're Solving the World's Greatest Mystery

On the plate, every star and galaxy made a double image, one taken with regular light, the other with ultraviolet. For ordinary stars and galaxies, the double images were approximately even in intensity. But for quasars, the ultraviolet image was far brighter. With this technique, he surveyed large areas of the sky.

Then came the shock. Many strange objects—not quasars, and certainly not conventional galaxies—began showing up. They looked like quasars on photographs; that is, they radiated huge amounts of ultraviolet. But no radio waves. Sandage named them "quasi-stellar blue galaxies." Some astronomers now think the quasars, these strange blue stellar objects (BSOs), and normal galaxies may all be different evolutionary stages of the same thing.

But whether that turns out to be the case or not, the BSOs are useful tools in answering the Big Question. Sandage estimates that there are 500 times as many BSOs as quasars—perhaps 100,000 easily visible. "The quasi-stellar blue galaxies are so numerous and reach so far into space," he says, "that we should be able to determine . . . the slowing down of the expansion of the universe within a few years."

But already Sandage and his colleagues are beginning to see the outlines of the answer: "The clues indicate," he says, "that our universe is a finite, closed system originating in a big bang, that the expanding universe is slowing down, and that it pulsates once every 80 billion years."

And so, while some uncertainty remains, the picture is getting clearer. The scientific detectives have almost solved the world's biggest mystery.

Born in fire. It's an awesome portrait of our universe they are drawing. On some day lost in the past, it was born in Promethean fire; on another day far in the future, it will go plunging to its doom, to perish in cosmic catastrophe, and to be born again, with new galaxies, new suns, new planets, and—there is no reason to doubt it—new people, perhaps like us. Nor were we the first. Through an infinite past, through uncounted cycles, whole galaxies and the civilizations clinging to them lived and died.

And in each stellar generation, no doubt, there were men able to look into the sky, to ask the great question, and, ultimately, to understand the grand scheme of the universe. ■ ■

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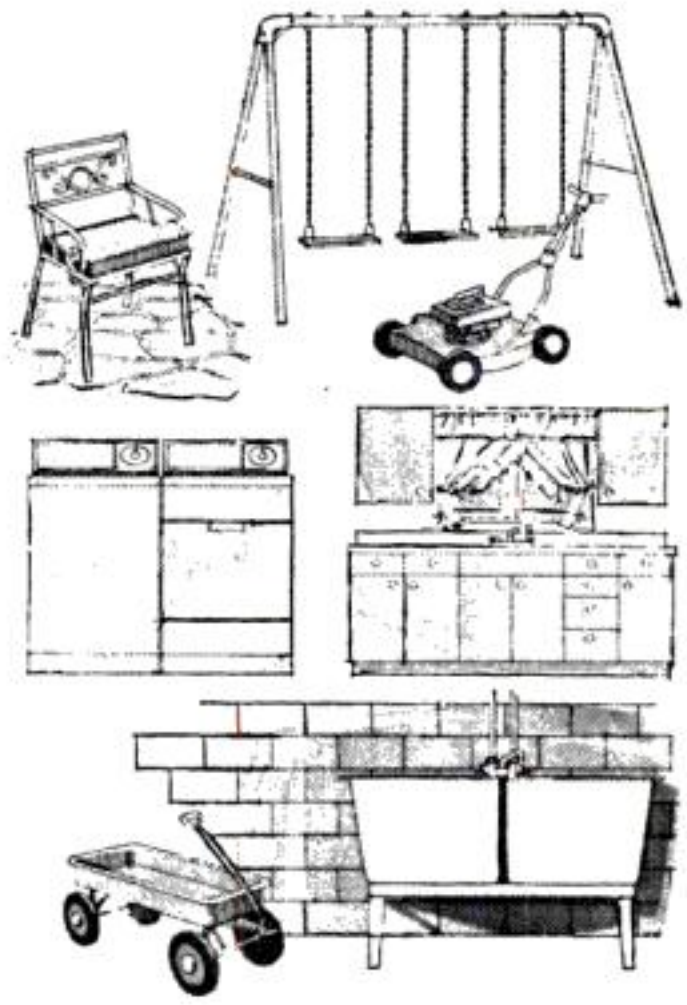

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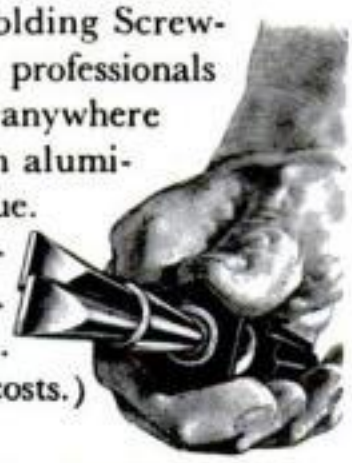

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Machines That Let You Carry a Ton

[Continued from page 72]

Ronald Patterson, a Cornell lab technician, but is adjustable enough to fit anyone of near-average build. Patterson has done a lot of walking, running, climbing, and lifting in this harness, with the joints wired to measure the range of movement and speed at each point. Now Cornell proposes to build a powered version of the arms and shoulders; later a completely powered superman suit can be put together.

The powered version will consist of two layers, Mizen said. The inner layer will be a harness like the present exoskeleton, strapped to the man. The harness will be linked to an identically jointed outer load-bearing structure, but not rigidly. At each joint a servo valve will register the angular movement of the harness joint. This will control the flow of fluid into a rotary hydraulic actuator that applies torque to the same joint of the outer structure to line it up with the harness joint. The servo valve will feed back a small amount of force to the harness, so the man is aware of the position of the outer structure.

Feeling his weight. The man will feel only a small fraction of the weight he is carrying. He has to feel enough weight to get a sense of balance when he moves the load—a few pounds at most. When he holds it steady, the sensation of weight will diminish.

Only experiment will show how easily a man can learn to use the powered exoskeleton. When he moves any part of his body, there will be a time lag before the structure moves; and when the load shifts, there will be a delay before he can respond. He will have to learn how to avoid staggering out of control. Also, there's no way to reduce the unbalancing forces caused by swinging or turning a heavy weight—there's always a danger that momentum will topple the man in the superman suit.

Falling under the weight of the exoskeleton and its power pack (about 500 pounds altogether) could be serious. Mizen thinks there will have to be some sort of panic button so the operator can instantly lock all the joints to prevent injury if he feels himself falling.

The Cornell engineers feel that these problems can be solved, that an exoskeleton that lets a man handle a ton—for a start—will be developed successfully. After that, the number of things it can be used for are limited only by your imagination. ■■

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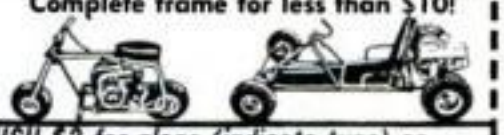

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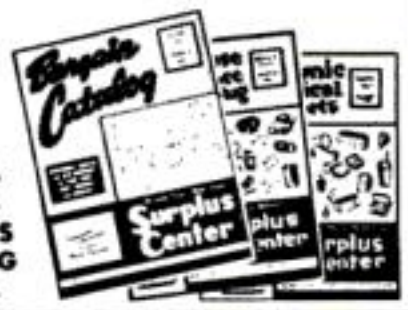

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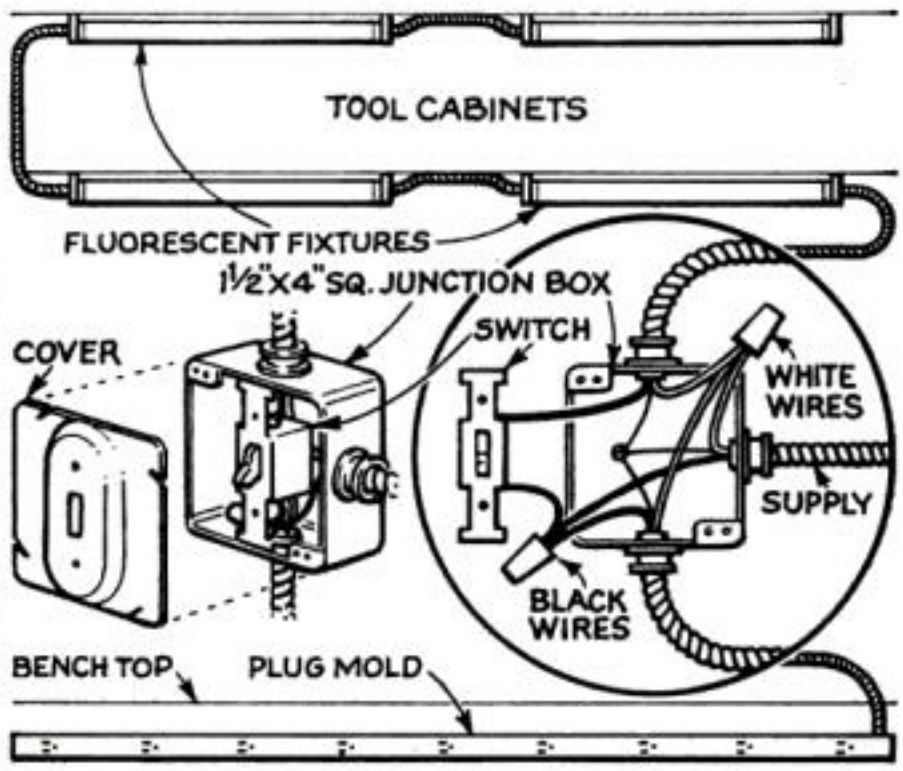
[Continued from page 169]

plywood. But for better appearance, you might want to go to birch plywood.

For the same reason—and for years of service—you might like to use a bench top of laminated maple as shown in the prototype. Your local building-supply store should have it or be able to order it for you. (The top used in the prototype cost $4 a square foot from Quality Maple Block Co., 341 E. 109 St., NYC.)

However, you can laminate an excellent work surface from two panels of ¾" fir plywood, topped with two pieces of ⅛" hardboard or one of ¼". Screw on the hardboard so it can be replaced. ■ ■



The switch and all the wiring fit a single junction box of the size shown. Recess box in back panel above the bench. Run one cable under bench to plug-in strip; another to the lights.

LIST OF MATERIALS

For Unit A: 12′, 2″-by-4″ pine; 5′, 1″-by-6″ clear pine; 4′, 1″-by-4″ clear pine; 28′, 1″-by-2″ clear pine; one 4′-by-4′ sheet ⅛″ perforated board; one 2′-by-4′ sheet ¼″ hardboard; one 4′-by-8′ sheet ¼″ fir plywood; two 4′-by-8′ sheets ¾″ fir plywood; two 30-watt fluorescent fixtures and bulbs; three sliding-door pulls, Stanley CD-482F #2; 4′ sliding-door track, Stanley #3034; 4′ grounded outlet strip; one tubular sliding-door lock, Corbin; twelve ½″ spacers for perforated board; 1½″-by-4″ square junction box; electrical switch; switch-plate junction-box cover; electric cable; glue; nails; screws.

For Unit B: same as unit A, plus: 4′-by-4′ sheet of ¾″ fir plywood; three more sliding-door pulls; another 4′ grounded outlet strip; an additional 4′ sliding-door track; one more sliding-door lock; plus 8′ of metal shelf strips. Another junction box, switch or switch-plate cover will not be needed, but additional electric cable, glue, nails and screws will be necessary.

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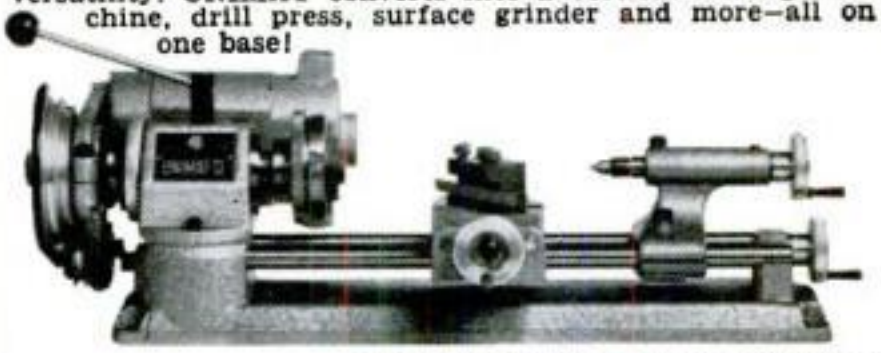

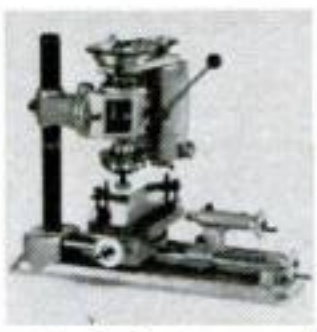

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[Continued from page 163]

plied by one 115-volt leg and the lower outlet by the other. Because the latter arrangement tends to balance load, it's desirable for kitchen-appliance outlet circuits. But because it puts 230-volts in the same outlet box, it's perhaps not advisable for workshop outlets that a youngster might use for electrical experiments. Some shops are childproofed with a master switch that can be padlocked.

● Finally, make the service-panel connection. Hook the three-wire circuit's red and black wires to fuse receptacles on opposite sides of the 115/230-volt service or to a two-pole circuit breaker. The fuse or breaker protecting each hot leg of the circuit should have a 20-amp rating. Connect the white neutral wire to the panel's ground strap. Make sure that no fuse, breaker, switch or other device interrupts the white neutral conductor.

Before reconnecting the original 15- or 20-amp circuit to supply current to overhead lighting fixtures, safety-check the old wiring, inspecting and retaping all splices.

Chances are you'll want to make some improvement in your shop-area lighting. To determine whether the existing lighting is adequate, measure the room's level of illumination in foot-candles. An incident-light photographic exposure meter will give you reasonably accurate foot-candle readings.

The illumination level optimum for shopwork depends upon the work being performed. A hard-to-see job—repairing a watch, for example—requires intense illumination, around 200 foot-candles. At least 100 foot-candles is desirable for precision toolmaking. For woodwork with power tools you should have approximately 50 foot-candles. For blacksmithing, 25.

Lighting engineers have found that at these illumination levels a craftsman with perfect vision experiences minimum eyestrain, makes a minimum number of errors, and has the minimum number of accidents. If your eyesight isn't 20-20 (more than half the population has less-than-perfect vision), proportionately higher levels may be advisable.

In the ordinary home shop, a general illumination level of about 30 foot-candles together with somewhat brighter local lighting at benches and power tools, 50-60 foot-candles, are satisfactory. ■ ■

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7590 — Power Drill $3.98

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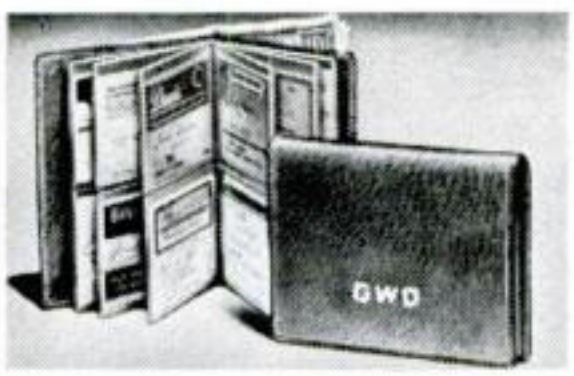

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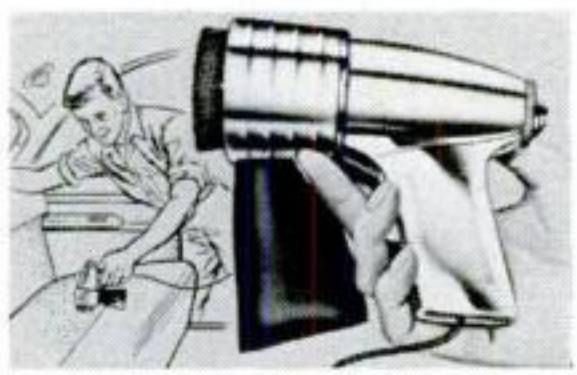

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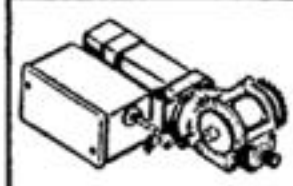

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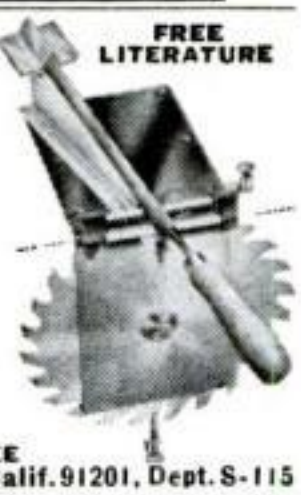

"TRU-CIRCLE" saw set automatically sets teeth at 10° or more. **$2.95 PPD.**

MONEY BACK GUARANTEE
A. D. McBURNEY, 1610 Victory Blvd., Glendale, Calif. 91201, Dept. S-115

Why Can't We Make Cars Safer?

[Continued from page 67]

soon. Better and more durable shock absorbers than those furnished as original equipment are available.

Enough research has already been done to enable manufacturers to equip cars with tires that meet basic safety standards. Senator Gaylord Nelson has introduced a bill that would set federal standards for tires. But even if manufacturers meet these standards, more safety education and better inspection regulations are also needed to remind drivers that tires must be checked often and replaced when unsafe.

Very often passengers can't benefit from the cushioning effect auto bodies afford on impact because they are thrown from the car when the doors fly open. It's standard practice in stock-car races for all cars to be bolted and strapped shut. The average driver can't do this, but perhaps a bank-vault type sliding-door latch would offer greater protection than those in use.

Regulations for safety. For all other means of transportation we have a pattern of cooperative state-federal regulation. Planes, buses, trains, and ships are kept safe through the enforcement of basic safety regulations. We require today that railroad passenger cars be made of steel instead of wood that can splinter in crashes. Minimum lifeboat standards exist for steamships, and licensing and operating standards have been set up for private and commercial aviation. We know what these regulations have accomplished.

The Federal Aviation Agency spent over $6,000,000 this year on research. With this fairly small sum, the FAA helps to provide an almost accident-free commercial aviation system in our country. We spend $1.3 billion for health research. The National Aeronautics and Space Administration is spending several billion dollars to insure a high degree of safety for our astronauts. I think we can afford $150,000,000 each year to make our cars and highways safe.

And we can make cars safer. If it takes federal regulation in order to reduce our tragic traffic injury and fatality rate, responsible Americans will demand that these regulations be established.

As a first step, I hope that all Americans join me in supporting a bill I am cosponsoring that will create a National Highway Traffic Safety Center. ■■

Urheberrechtlich geschütztes Material

[Continued from page 78]

But perhaps the most irritating thing about power steering is the way these cars are content to travel *almost* straight instead of *dead* straight. When coming out of a turn, the self-centering action stops when the front wheels are still two or three degrees off. Even when traveling straight on a level road, you cannot drive "hands off" with any assurance that the car will continue in a straight line. When making this test, they all veered off course pretty soon. You have to steer these cars every inch of the way.

Power brakes that come on full strength at the touch of a toe can be quite a hazard. The 1966 models are improved in this respect, but a lot more pedal feel can be built into the system before any complaints of high pedal effort are justified.

The auto makers mistrust you, underestimate you, and give you their idea of a foolproof car. But control systems that are more alive to the vehicle's attitude and behavior would put the driver in better command—and *really* make him safer.

Perhaps the best advice I can give you if you are slightly fanatical about your driving and like to be complete master of your car is to do without power steering and without power brakes (until we get better power-control systems).

Naturally, we gladly put up with the shortcomings of power steering if we have to do a lot of parking and maneuvering. But I can't find any excuse for a feather-touch power brake.

At the wheel. If you could give me the Impala's driving position with the Galaxie pedal arrangement and the Plymouth instrument panel, I'd have a pretty good setup. Ford stands alone in the use of a suspended accelerator, and it's surprising how much difference it makes.

The competitor within: Now that we've been through the cars point for point and I have given you my opinion in each area, you'll understand why it's impossible to end by saying that I would prefer a Chevy over a Plymouth. Or a Ford. I have strong likes and dislikes about each of them. But I have something else on my mind, too. I'd probably prefer a Chevelle over the Impala, a Fairlane over the Galaxie, and a Belvedere over the Fury. Watch for my Driver's Seat Report on the intermediates in a future issue. ■ ■

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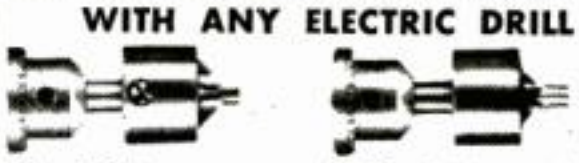

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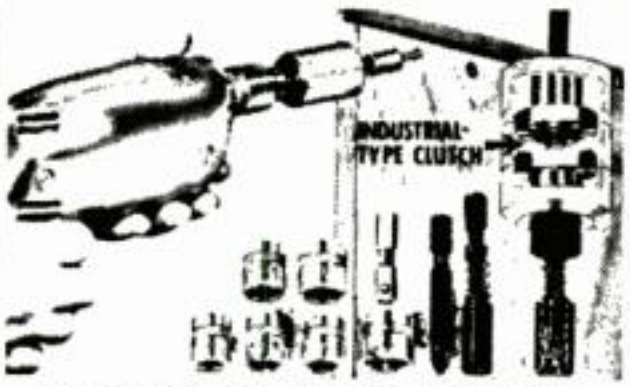

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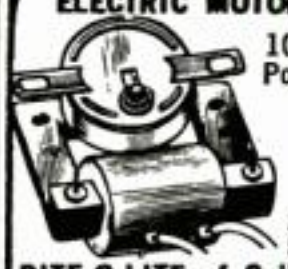

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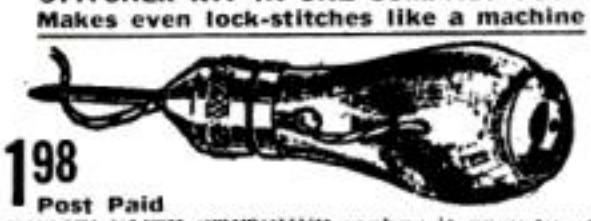

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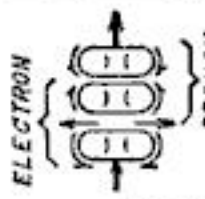

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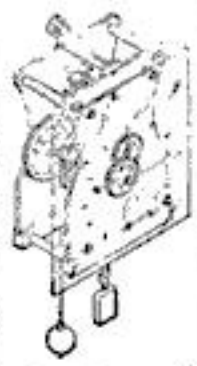

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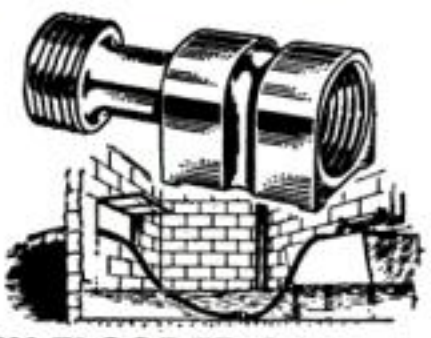

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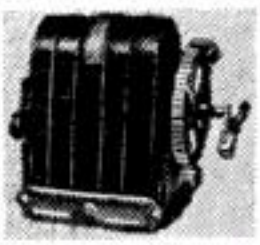

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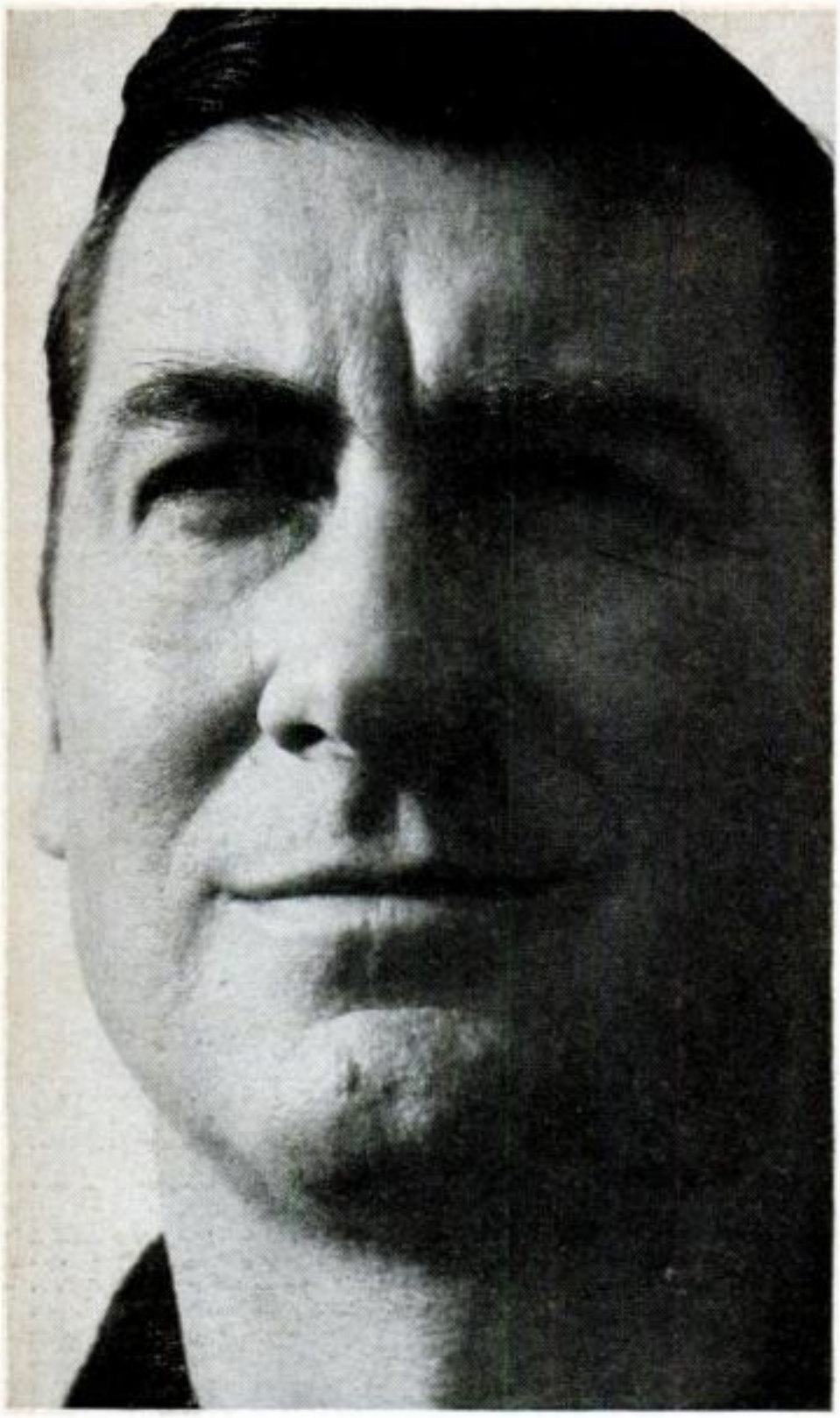

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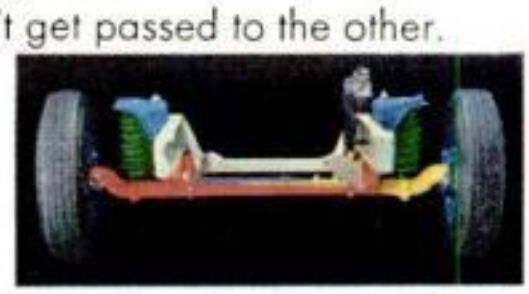

Ford also puts husky I-beam radius rods up front to hold wheel alignment and reduce tire wear.

Together, they make an independent suspension that no other pickup can match for smoothness . . . toughness.

Engines are smoother, too. Two big new, seven-main-bearing Sixes have such performance, we had to develop a new V-8 to stay ahead of them.

So are we worried? Not when our biggest concern is building enough to meet the demand. So far this year our sales are up eighteen percent.

Come on in and check us out. Action-test a new Ford today.

FORD/66

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Introducing the tuned car. 1966 Buick.

What makes a car a car is styling, performance, ride and handling. Only when they're all tuned together is the car a Buick. Like this '66 Riviera Gran Sport.

Every last thing that goes into a Buick—suspension, body mounts, shock absorbers—not only has to work, it has to work with everything else. That's tuning.

Tuning is what we do more of (and care more about) than anybody we know of. And then we go out and test it in more places, too. On roads like the ones you'll be driving on. Why we do it will be obvious when you take your first ride. The tuned car rides and handles as handsomely as it looks. (Tuning may be hard to explain. But it's easy to notice.)

What the tuned car will do for you. And your family. For a start, the new Riviera will comfort you. You'll see that when you slip into the Riviera's new bench seats. Space for six. If you like buckets, they're available, with a reclining arrangement for the right-front passenger. And we have another comforting option available: a new notch-back seat that converts from bench to semi-bucket.

Choosing the tuned car. Visit your Buick dealer. Every Buick you see is the tuned car. Riviera, the new international classic. Riviera Gran Sport. *Every* '66 Buick.

And with a choice like that, how in the world can you go wrong?

Wouldn't you really rather have a Buick?

BUICK MOTOR DIVISION

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